This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

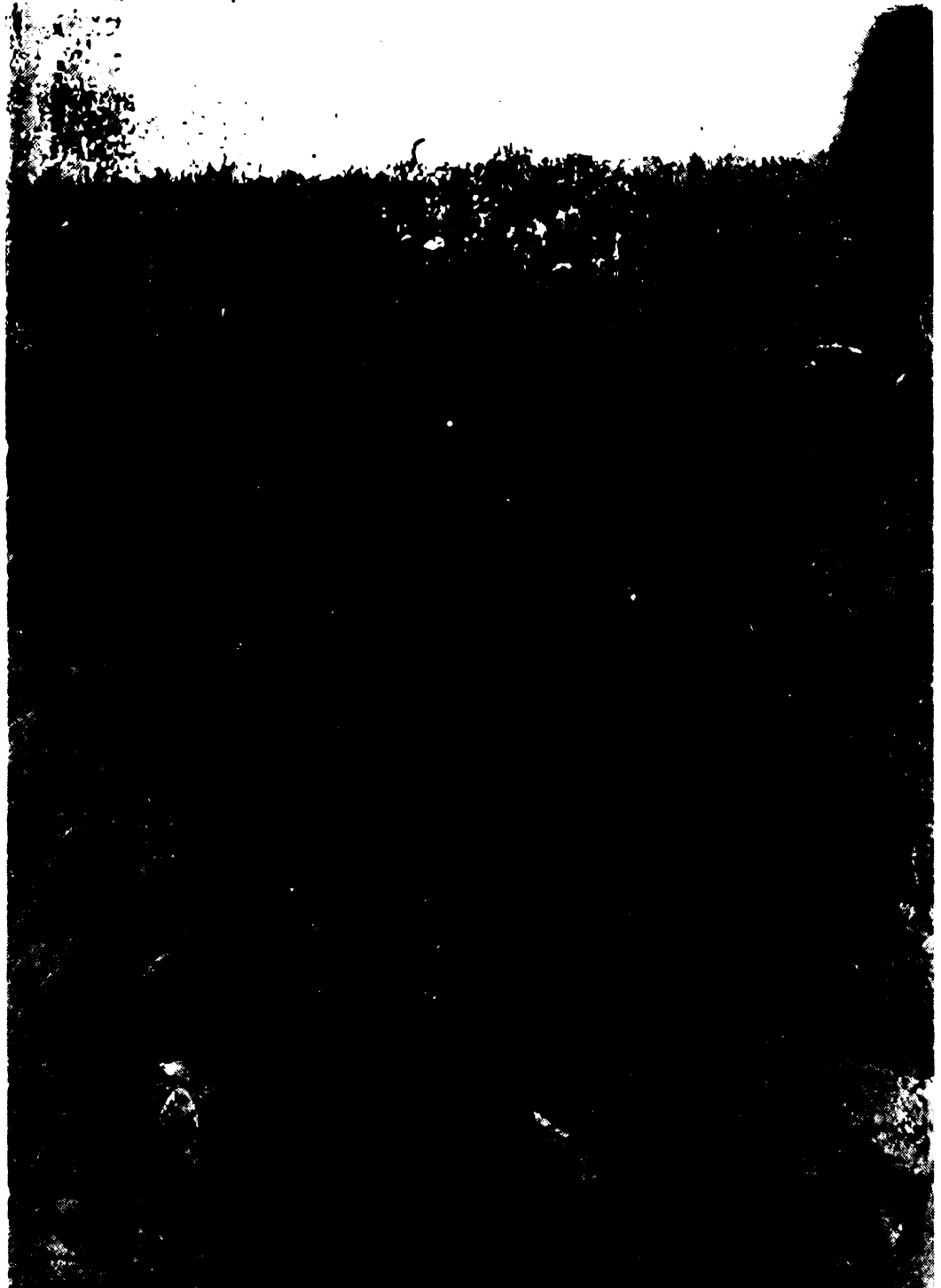
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



Memoir

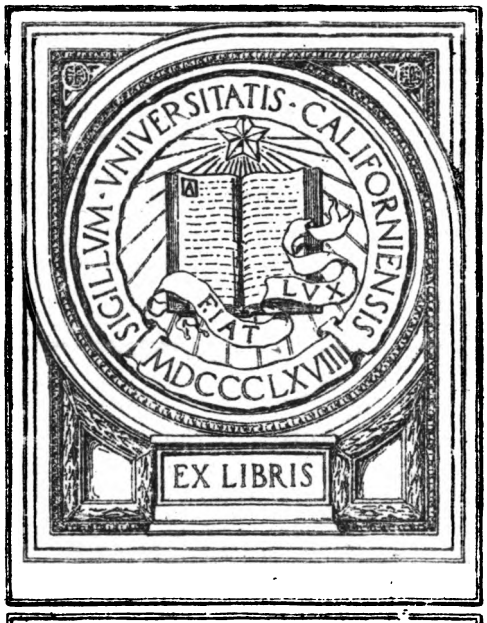
Transvaal (Colony). Geological Survey

Digitized by Google

BERKELEY
LIBRARY
UNIVERSITY OF
CALIFORNIA

EARTH
SCIENCES
BRARY

GIFT OF



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

South Africa

MINES DEPARTMENT.

GEOLOGICAL SURVEY OF THE TRANSVAAL

The Geology of Pretoria and Neighbourhood:

An Explanation of the Geological Map of the Environs of Pretoria

BY

A. L. HALL, B.A., F.G.S.

[Sachs mag]

PRETORIA:
PRINTED AT THE GOVERNMENT PRINTING AND STATIONERY OFFICE.

1905.

Digitized by Google

GE325
A36
v.1
EARTH
SCIENCES
LIBRARY

Digitized by Google

CONTENTS.

	PAGE.
PREFACE	v.
INTRODUCTION	vii.
CHAPTER I.—	
Physical Features	1
CHAPTER II.—	
General Description of the Geology	10
The Formations and their Distribution	10
The Dolomite	10
The Pretoria Series, Quartzites	15
The Pretoria Series, Shales	20
Igneous Rocks	22
CHAPTER III.—	
The Geological Structure	28
General Remarks	28
Main Lines of Dislocation	30
The Structure of the Timeball Hill Series and Dolomite in the South-east	36
General Nature of the Movements	38
CHAPTER IV.—	
Boreholes	43
CHAPTER V.—	
Economic Geology	49
Water Supply	49
Cement	53
Bricks	54
Slate and Building Stone	55

LIST OF ILLUSTRATIONS.

PLATE I.—General view from summit of Klapperkop. (Frontispiece.)
" II.—Dolomite in railway cutting W. of the Fountains.
" III.—Dolomite with interstratified shales. Fountains.
" IV.—Wonderboom Poort.
" V.—Magaliesberg quartzite. Wonderboom Poort.
" VI.—Quarry. South slope of Meintjes Kop.
" VII.—Spheroidal weathering in diabase. Waterkloof.
" VIII.—Termination of East Fort Range against the Struben Kop Fault.
" IX.—Contorted shales near Lynwood Fault. Waterkloof.
" X.—Section from Old Natal Road to McKenzie's Farm. Vertical Section of Time Ball Hill Series.
" XI.—Dip slopes of slate. Garstfontein.
" XII.—Slate Quarry. South slope of Schanskop.
" XIII.—Section 1. From near Lyttelton Junction to Derdepoort.
" XIV.—Section 2. From Zwartkop to the Magaliesberg.
Section 3. Across Pretoria from Schanskop to the Daspoort Range.

343036

Digitized by Google

Digitized by Google

PREFACE.

The following pages are intended to provide a detailed description and explanation of the Geological Map of the Environs of Pretoria, recently completed by the Geological Survey, and now issued together with this accompanying memoir.

The somewhat complicated nature of the geological features of the neighbourhood of the Capital, combined with the importance of a clear comprehension of their structure, rendered it advisable to map this area in greater detail than can be attempted in the general geological survey of the country. For this purpose the map of the environs of Pretoria, on the scale of two inches to the mile, issued by the Surveyor-General, offered the most suitable and reliable topographical basis. This map includes an area, immediately surrounding the Capital, of 180 square miles, and permits of the delineation of the stratigraphical peculiarities of this interesting area with an accuracy of detail, that would be impossible on the smaller scale maps in general use. The work of the detailed geological mapping was executed during the months of November and December, 1904, and part of January, 1905, mainly by Mr. A. L. Hall, while Mr. F. A. Steart rendered some valuable assistance.

The present memoir not only serves as a guide to this map, but also contains a varied stock of information, collected by the author, Mr. A. L. Hall, relating to the more practical questions associated with the geology, such as water supply, economic products, etc., of which as yet there has been no connected account available. The detailed stratigraphical succession, and especially the complicated structure of the south-eastern portion of the area, have been as carefully and systematically worked out as was possible in the comparatively short time available, and are here fully described and discussed by Mr. Hall.

The photographic illustrations have been selected so as to show the conspicuous features of the more important and characteristic strata. The sections have been carefully plotted out, so as to illustrate the stratigraphy and structure of the area in as comprehensive a manner as possible.

HERBERT KYNASTON, *Director.*

Geological Survey Office,
Pretoria, 25th March, 1905.

Digitized by Google

Digitized by Google

INTRODUCTION.

The following pages present a concise account of the geological features of the town of Pretoria and neighbourhood, in illustration of the map published simultaneously with this text. In order, therefore, to fully appreciate the following, a study of this map is essential.

The area, from which the material for this memoir was gathered, is co-terminous with that of the map, which embraces nearly 180 square miles, or, in other words, the environs of the Capital within a radius of approximately 8 miles. This includes on the north the country just beyond the Magaliesberg Range, in the east to Silverton, on the south as far as Erasmusdam, and in the west to the Leper Asylum. Advantage has of course been taken of the information obtained in areas beyond the limits of the map, especially where such information assists—as, for example, in the case of the Hennops River Valley to the east of Irene—in the proper understanding of the geological problems, with which we are immediately concerned.

The field-work in connection with this memoir was done during the months of November, December, 1904, and January, 1905, the greater portion having been mapped by the writer, ably assisted by Mr. F. A. Steart. As a topographical basis the very accurate map of Pretoria and Environs, published by the Surveyor-General, was used. The scale of this map is two inches to the mile, and being in addition well contoured, it allows the geology to be represented with accuracy. The method of work adopted was briefly as follows:—As many important points of secondary control as possible were fixed on the map in addition to those already given. The area was then surveyed geologically, and wherever any uncertainty existed as to accuracy of position, plane-tabling was resorted to. In localities where the presence of much magnetite-bearing rock did not allow the table to be accurately set, a convenient distance was measured off in a suitable direction, away from magnetic influences, and the original point thus located.

Digitized by Google

The geological boundary lines delineated in the map amount to 457 linear miles. Generally speaking, the tracing of these did not afford great difficulties, excepting where they approach and traverse the town and some of its suburbs. Fortunately, a considerable amount of information was available from boreholes, and this enabled the boundary lines to be ascertained with greater accuracy than would otherwise have been possible. The presence of much cultivated land, gardens, etc., rendered the mapping of the town somewhat uncertain, but a systematic examination of the unlined water furrows, wells, etc., afforded in many instances valuable help.

In Chapter I. the main physical features of the district are described, as they are of primary importance in following out the geological structure. In this connection a list of the elevations of the principal points in and around the town should be of interest.

In Chapter II. a general account is given of the sequence and nature of the formations represented in the map, their influence on the landscape, mode of weathering, etc.

Chapter III. deals with the geological structure, and describes the nature of the movements, which the rocks have undergone.

Chapter IV. contains a list of boreholes and their records. This shows that the information obtained from this source agrees with the geology recorded from the examination of the surface.

Lastly, in Chapter V., the main points of economic interest are briefly reviewed, such as the Pretoria water supply, building stones, etc.

The writer desires to express his thanks to a number of gentlemen who were kind enough to supply him with information not strictly geological; to Mr. Aug. Karlsen, of the Irrigation Department, he is indebted for information connected with water supply and certain levels; to Mr. Badcock, Town Engineer, and Mr. F. van der Ben, chief draughtsman, for the levels along Aapies River and elsewhere; to Mr. Stuart, hydraulic engineer, for information on the subject of boreholes.

Digitized by Google

The Geology of Pretoria and Neighbourhood.

CHAPTER I.

PHYSICAL FEATURES.

The most striking feature, which characterises the neighbourhood of Pretoria is the impression one receives of a regular alternation of lines of hills with gentle valleys.

Standing at Klapperkop Fort, at an elevation of 5,085 feet above sea level, an observer looking northward notices several conspicuous and more or less broken lines of hills, running nearly due east and west. The most northerly and impressive of these is the Magaliesberg Range, rising in the west, close to Horn's Neck, to a height of 4,976 feet. From this point towards the east there is a gentle fall of the summit-level of the range, until, at Wonderboom Fort, the altitude is only 4,649 feet, and still further east, the summit drops to 4,568 feet near Derdepoort. Thus, over a distance of about 16 miles, within the limits of the map, we have a fall of about 400 feet in the crest line of the Magaliesberg Range, while its highest point is about 110 feet below our point of view at Klapperkop. The average elevation of this range may be estimated at 4,790 feet.

Immediately to the south of this range the observer notices a broad stretch of low ground steadily falling to the north and about 2 miles in width. It may be conveniently referred to as the Daspoort depression. The mean elevation of this hollow may be taken as 4,210 feet, between the extremes of 4,368 feet near Koodoespoort Station and 4,050 feet at the Wonderboom drift, the latter point being nearly 600 feet below Wonderboom Fort. The Daspoort depression is traversed midway from south to north by the Aapies River, towards which the ground falls both from the east and west.

Running parallel to Magaliesberg Range, on the south side, the observer will notice another long range of hills, less conspicuous in height and presenting moreover the appearance of being duplicated along part of its course. This is the Daspoort Range, formerly known as the Witwatersberg. Like the Magaliesberg Range, it gradually rises in a westerly direction; the West Fort, at

Digitized by Google

an elevation of 4,963 feet, being in fact only 13 feet lower than the corresponding point on the Northern Range east of Horn's Neck. In an easterly direction, the range gently falls to near 4,600 feet close to the point where the northern railway line traverses it; from which position it continues to fall gradually, until it comes to an abrupt termination about half a mile west of the Kilnerton Mission Station. The average elevation may be considered as 4,600 feet.

For a distance of about two miles from its eastern extremity, the Daspoort Range overlaps a third line of hills—conveniently called the Meintjes Kop Range—which runs from west to east for about 10 miles. Rising rather suddenly on the east side of and close to the main Wonderboom road, this range begins with a well marked feature—Meintjes Kop, which attains a height of 4,712 feet, thence continues to the east, passes the Delagoa Bay Railway at Koedoespoort, is cut by Hartebeest Spruit about a mile south of Silverton, and finally terminates abruptly just a mile beyond the eastern limit of the map. As before, one finds this range also becoming less elevated from Meintjes Kop, which markedly overlooks the Daspoort Range, towards the east.

Following these ranges on the south lies the Pretoria depression, a somewhat irregular belt of gently sloping ground, the centre of which is occupied by the town itself. Owing to a gentle feature culminating in Proclamation Hill—4,447 feet—the depression towards the west is split into two branches, the northern one continuing along Skinner Spruit to West Fort, the southern one extending to Quagga Poort.

Soon after crossing Aapies River, which traverses the main hollow in a direction more or less from south to north, the ground rises in the suburbs of Arcadia and Sunnyside, until we reach a subsidiary water-shed, which runs, approximately, from Bryntirion through Rissik Station towards McKenzie's Farm. To the east of this water-shed, one can recognise two main valleys. The northerly one runs for a short distance parallel to the Delagoa Bay line, and then continues between the Meintjes Kop Range on the north and the East Fort Range on the south, the latter suddenly rising on the west in Strubenkop—4,762 feet. The southern valley is wide and open, and runs from Uitval towards Garstfontein, forming the hydrographic basin of Hartebeest Spruit.

Digitized by Google

The following series of levels will give some idea of the amount of fall across the Pretoria depression from south to north :—

LIST OF LEVELS TAKEN ALONG MARKET STREET FROM SOUTH TO NORTH.

At Station	4,450.0	
At Skeiding Street ..	4,441.7	Beween Station and centre
At Maré Street	4,431.3	of Church Square:
At Minaar Street.. ..	4,414.2	Diff. in height: 96·8 feet.
At Visagie Street ..	4,399.4	Length, 4,200 feet.
At Skinner Street ..	4,386.6	Gradient 1 : 44.
At Schoeman Street ..	4,370.2	
At Pretorius Street ..	4,360.7	
At centre of Church Square	4,353.2	
At Law Courts, south steps	4,348.2	
At Vermeulen Street ..	4,339.1	Between centre of Church
At Proes Street	4,331.2	Sq. Aapies River due N.
At Struben Street ..	4,322.3	Diff in height: 111.6 feet.
At Blood Street	4,310.8	Length : 4,200 feet.
At Boom Street	4,295.6	Gradient 1 : 37.
At Aapies River.. ..	4,241.6	

Each number denotes the height above sea level at the points, where the middle line of Market Street cuts that of the streets running east and west. The above series of elevations is embodied in the section, Fig. 3, Plate XIV., which is continued from the station across the southern ranges to the Fountains.

To convey an idea of the rise of the Pretoria valleys in the easterly direction, a list of levels is given below, taken from the centre of Church Square over Arcadia Bridge along Church Street.

LIST OF LEVELS FROM CHURCH SQUARE TO THE EAST.

Church Square	4,353.2	Between Church Square
Andries Street	4,344.6	and Arcadia Bridge:
Van der Walt Street ..	4,339.4	Diff. in height: 32.2 feet.
Prinsloo Street	4,337.7	Length 4,450 feet.
Du Toit Street	4,325.9	Gradient 1 : 138.
Arcadia Bridge	4,322.0	
Beatrix Street	4,340.0	
Hamilton Street	4,364.7	
Leyds Street	4,394.5	Between Arcadia Bridge &
Wessels Street	4,426.3	summit of Church Hill :
Johann Street	4,454.9	Diff. in eight: 243.4 feet.
Beckett Street	4,489.3	Length, 9,400 feet.
Farenden Street	4,505.7	Gradient 1 : 38.
Eastwood Street	4,513.9	
Orient Street	4,538.5	
Hill Street	4,563.1	
Highest Point (Bryntirion)	4,565.4	

Digitized by Google

Further information regarding the elevations of some of the more important points in and around the town can be obtained from the general table of heights on page 9.

Let us now return to our position at Klapperkop Fort. Immediately to the north lies a range of hills, which becomes very low and soon dies out towards the east, but traced to the west continues for about three miles, becoming gradually higher, until to the south of the Lunatic Asylum, it attains to 4,903 feet. Soon after passing this point, it rapidly dies out, although the formation which gives rise to this line of hills, can be traced as far as a point north of Quagga Poort. This is the Timeball Hill Range —the line of broken hills which are seen to rise immediately south of Pretoria Station. It is succeeded on the south by a narrow hollow, beginning at the high ground about a quarter of a mile north of the Johannesburg Road Redoubt. This hollow runs to the east between Schanskop Fort and Timeball Hill; crosses the Aapies River valley north of the Fountains, continues through the Government Plantation and Muckleneuk to finally merge into the broad Garstfontein valley towards the south east.

The range, on which the observer stands, comprises several high points, such as those, on which are placed Klapperkop Fort (5,085 feet), Schanskop Fort (4,994 feet), the Johannesburg Road Redoubt, and Quagga Fort (5,062 feet). From Klapperkop Fort it continues as a somewhat irregular belt of high ground through Waterkloof and Erasmusdam towards the south-east. To the west of Klapperkop Fort it is broken through by the Aapies River, but soon rises again into the high ground at Schanskop Fort, whence it continues to beyond Quagga Poort. Thus again, as in the case of the Daspoort and Meintjes Kop ranges, we find a duplication of lines of hills. This repetition of high ground is very important in connection with the geological structure, as will be shown in Chapter III.

Let the observer now change his position and view the country to the south and south-west. He will first of all notice a striking valley along the Johannesburg line. This is the upper part of the Aapies River valley. Then, along the southern side of the Schanskop Range, he will see a gentle depression running from the railway line to the west, and from the foot of Klapperkop to the south-east along the north-east side of the Standerton road. Everywhere to the south of this line of low ground,

Digitized by Google

he no longer sees the constant repetition of more or less straight ranges and valleys, but numerous kopjes marked by masses of rough and dark-coloured rock, passing into high undulating ground. This change in the type of scenery denotes the fact that we have passed from the Pretoria Series to the Dolomite formation, which, generally speaking, in this area forms rather high ground, averaging 4,900 feet, though rising now and then into marked features, such as Zwart Kop, 5,021 feet, until in the south-west corner the country falls rather sharply to the Hennops River.

A closer examination of the ground shows, that the main topographical lines are by no means as simple as they appear from the above remarks. Thus, the first impression one receives of the ground to the south of the station is rather that of a number of hills than of ranges, but a study of the map shows that the apparently isolated hills are, in many cases, only portions of continuous formations which have become locally emphasised by denudation.

Omitting minor details, we may summarise from the above remarks the distribution of high and low ground in a direction from north to south somewhat as follows :—

MAIN TOPOGRAPHICAL LINE EAST AND WEST.

Magaliesberg Range.
Daspoort Depression.
Daspoort and Meintjes Kop Ranges.
Pretoria Depression:
  a. W. of town: Skinner's Spruit branch. Quagga Range branch.
  b. E. of town: Closed by a lesser watershed beyond which lie: Koedoespoort Valley. Garstfontein Valley.
Timeball Hill Range.
Muckleneuk Depression passing into Garstfontein Valley.
Schanskop Range.
Standerton Road Depression.

MAIN TOPOGRAPHICAL LINES NORTH AND SOUTH.

Aapies River Valley.
Hartebeest Spruit Valley.

Digitized by Google

When the hill ranges are more closely examined, it is found that their continuity is frequently interrupted. Thus the Magaliesberg Range shows two well marked gaps; one at Wonderboom, which allows for the passage of the Pietersburg Railway; the other at Derdepoort. Similar openings or poorts in the lines of hills are to be seen at various places. Usually one finds them traversed by a spruit, as in the case of the two poorts named and Daspoort. In such cases the discontinuity may be due to the corrosion of the stream bed by the spruit. In other cases, one finds equally well marked poorts without their forming natural water-courses.* In such cases it is sometimes possible to prove the existence of faults which have broken through and more or less shifted the broken ends of the range, causing an interruption which may vary from a very slight displacement to a considerable lateral shift of some miles in length. An excellent example of such a gap produced by faulting is afforded by Quagga Poort, and by the gap in the Meintjes Kop Range south of Silverton.

The hills owe their origin to the fact that they consist of hard quartzite lying between soft shales, which latter are worn down by the general influence of denuding agents faster than the harder rocks.† These, therefore, tend to stand out as ridges. Their east and west trend and the different characters of their northern and southern slopes follow from the general disposition of the beds belonging to the Pretoria Series. Since the dip is to the north and the strike east and west, the hill ranges form a number of more or less steep escarpments facing to the south, while the northern slopes are more gentle, and are approximately dip slopes. This is particularly true of the northern ranges, while south of the station this simple arrangement is complicated by a steeper dip of the beds and by minor undulations. Thus an observer, standing on the main road, leading from the British Residency to the Fountains a little to the south-east of the junction of the Delagoa Bay and Johannesburg lines, will see the beds constituting the Timeball Hill dipping at an angle considerably higher than that of the northern slope of the hill.

---

* These are probably analogous to what are known as 'Windgaps,' See T. C. Russell, River Development, Chapter VII, London, 1898.

† The whole topography forms an interesting example of the application of the Laws of Land Sculpture laid down in Chapter V of G. K. Gilbert's classical work. "The G. of the Henry Mts." U.S.G.G.S.R.M.R. Washington, 1880.

Digitized by Google

The physical features of the range of hills which extend from Klapperkop towards the south-east are particularly interesting. It will be shown below, when discussing the structure, that there has been here much folding and general undulation. In consequence of this, and of the sculpturing of the surface by water, the usual regularity in the topographical lines is lost and replaced by a belt of highly dissected ground. Some of the undulations are shown in the southern portion of Section No. 1, Plate XIII. Reference to the coloured map will show one locality on the north-west corner of Garstfontein, where the strata have been broken through by two faults and twisted round, thus giving rise to a completely isolated hill range.

The main drainage lines are those of Aapies River, Hartebeest Spruit, and Hennops River. These natural water-courses account for the whole of the surface drainage within the limits of the map, excepting in the extreme north-west corner. The hydrographic basins of these channels are very unequal in extent. We may take the water-shed between the Aapies River and Hartebeest Spruit to run from the extreme southern end of the Natal Road in a northerly direction through the centre of Waterkloof, thence in a north-north-easterly direction from the south-west corner of the farm Koedoespoort No. 299 towards the south-east portion of Doornpoort No. 505. The water-shed between the Hennops and Aapies River runs a little to the south of the range which runs through Quagga Fort as far as Schanskop; from this point the line runs parallel to and a little to the west of the Johannesburg line. Thus, the area of the map would be divided up among the three main drainage lines as follows :—

Aapies River, 60 per cent.
Hartebeest Spruit, 29 per cent.
Hennops River, 11 per cent.

We see then that the largest hydrographic basin is that of the Aapies River, forming nearly two-thirds of the whole area.

The source of the Aapies River lies to the south of the Fountains within the Dolomite formation, and a little to the south-west of the junction of this formation with the Pretoria Series. After following a north-westerly course for about a mile, the valley bends sharply to the

Digitized by Google

north close to the upper spring of the Pretoria water supply. From this point the river follows a meandering course, through deep cuttings in the beds forming the Schanskop and Timeball Hill Ranges, entering the Pretoria hollow a little east of the junction of the Johannesburg and Delagoa lines, and continuing to flow in a northerly direction as far as Struben Street. After its junction with Walker Spruit from the south-east, the Aapies River instead of flowing to the north, as one might have expected, turns near Hove's Drift sharply to the west, until, after a gentle fall over about two miles, it cuts through the Daspoort Range, immediately after receiving Skinner's Spruit from the west. Between this range and the Magaliesberg, its waters are further increased by several small tributaries from the east and west, before the main river has finally cut its way through the quartzites of the Magaliesberg Range.

The figures below give some idea of the fall in the water level :—

HEIGHT OF WATER LEVEL IN AAPIES RIVER AT VARIOUS POINTS.

	Feet.
Below Delagoa Line	4,410
Lover's Walk, Berea Park	4,402
Below Victoria Bridge	4,359
Water Street	4,336
Below Arcadia Bridge	4,311
Hove's Drift	4,275
North of Zoo	4,245
North of Kaffir Location	4,223
Below New Daspoort Bridge	4,187
Daspoort	4,174
Wonderboom Drift	4,047
Two miles north of Wonderboom Drift	4,000 (apprx.)

The headwaters of Hartebeest Spruit rise on the farms Garstfontein and Waterkloof in at least seven small streams. From Lynwood this river continues in a northerly direction towards Kameeldrift No. 521, occupying between Silverton and Lynwood a well marked valley. Between Derdepoort and the Delagoa Bay line there is evidence of a considerable amount of drift mainly composed of waterworn quartzite pebbles, the distribution of which does not quite agree with the present course of the waterway. Instead of following more or less the sides of the spruits, it extends some distance to the east and west, both in the case of Hartebeest Spruit itself, as well as in connection with the tributary spruit coming from

Digitized by Google

Koedoespoort to join the main drainage line about half a mile north of Derdepoort. It is possible, that a slight lateral displacement of the water courses tended to accumulate the drift in a direction more east and west.

The vegetation generally speaking is luxurious, the rapid growth of trees being a well known characteristic. The average rainfall may be taken as 26.3 inches per annum, while the mean maximum temperature for the three summer months is 89° F., the mean minimum temperature for the three winter months being 42° F., giving the considerable range of 42° F.

Table of Heights.—In view of the difficulty of obtaining information with regard to elevations, a list of heights is here added for some of the principal points of interest, both within and outside the limits of the municipality.

List of Principal Heights.

	Feet above Sea level.		*Feet above Sea level.*
Erasmus Dam	5,132	Pumping Station, south of Leper Asylum	4,532
Klapper Kop	5,085	Upper Spring Fountains	4,525
Kwagga Fort	5,062	Rail due east of Schanskop	4,513
Zwartkop	5,021	Lower spring at Fountains	4,510
Schanskop	4,994	No. 7 Hospital	4,486
Magaliesberg, east of Horns Nek	4,976	Station Rail	4,450
West Fort	4,963	Proclamation Hill	4,447
Timeball Range, north of Johannesburg Redoubt	4,905	Water level in Walkers Spruit below Delagoa Line	4,433
Johannesburg Road, south of Cantonments	4,900	Muckleneuk Poort	4,429
Cable Hill Redoubt, west of Wonderboom	4,826	British Residency	4,387
Koppie, north of Lynwood	4,793	Koedoespoort Station	4,368
Timeball Hill	4,774	Silverton Drift	4,367
East Fort	4,762	Model School	4,364
Meintjes Kop	4,712	Victoria Bridge	4,363
Wonderboom Fort	4,649	Centre Church Square	4,353
Railway curve above Fountains	4,607	Law Courts, foot of south steps	4,348
Daspoort, west of railway	4,600	Gymnasium, south door	4,318
Magaliesberg, east of Wonderboom	4,568	Entrance of Zoo	4,295
Wierdas Bridge	4,540	Racecourse	4,275
		Aapies River, north of Zoo	4,243
		Junction of Skinner Spruit and Aapies River	4,174
		Drift at Wonderboom Poort	4,047

Digitized by Google

CHAPTER II.

GENERAL DESCRIPTION OF THE GEOLOGY.

The Formations and their General Distribution.

The sedimentary formations, occurring in the area to be described, are constituted as follows :—

Quartzite and Shales—Pretoria Series Dolomite and Chert—Dolomite formation	Transvaal system.

The following igneous rocks also play an important part in the geology of the area :—

Norites.—Southern margin of Bushveld Plutonic Series.
Diabases.—Intrusive in Pretoria Series.
Diabases.—Intrusive in the Dolomite.
Eruptive Breccia.—Later than the Diabases.

The norite is confined to a long, narrow strip of country north of the Magaliesberg Range, and covers on the map about 23 square miles, while the dolomite is similarly confined to one portion of the map, namely, the south-west corner, where it crops out over some 27 square miles. The remaining ground, about 130 square miles, is occupied by beds belonging to the Pretoria series, with its associated igneous rocks. The mapping of the whole area of 180 square miles necessitated the tracing of 457 miles of boundary lines, or an average of 2½ miles of boundary to every square mile of surface. Where the original bedding is not complicated by faults or undulations, the general dip is to the north and north-east, varying in amount from 10° to 60°.

The Dolomite.

This formation forms about 15 per cent. of the whole area, and is confined to the southern and south-western portions. Its upper boundary usually coincides with a gentle hollow, which runs along the south side of the Timeball Hill Range ; well seen to the south of Quagga Poort, from which point it may be followed to the southern

Digitized by Google

Dolomite in Railway Cutting W. of the Fountains.

Digitized by Google

Digitized by Google

slopes of Schanskop. Here the formation runs for a short distance along the northern part of the curve made by the Johannesburg line, bends to the south-east, and follows the valley which lies at the foot of the south-eastern extension of the Schanskop Range, and a little to the north-east of the Standerton Road. Generally speaking, the upper boundary of the dolomite cannot be traced with certainty on the ground, but there are invariably indications, which enable one to ascertain approximately and to within 100 feet the position of the line of junction. Thus, along the junction we notice nearly always a belt of low ground covered with a deep red soil, to the south of which there are seen kopjes and ridges made up largely of rough blocks of chert, while to the north rises a well-marked line of well-bedded, reddish quartzite.

Within the limits of the map there are two localities of exceptional interest in connection with the relationship between the dolomite and the overlying beds. These are at the Fountains and at Quagga Poort. The railway line between the stations of Ashbury (on the south) and the Fountains (on the north) runs for the greater part through a cutting, which is well worth close study. Beginning at Ashbury, the line proceeds for a little way in a northerly direction, and on either side are seen good outcrops of dolomite, exposed in such a manner as to show approximately their true dip. The rock is rather thickly bedded, generally dark grey to black on the surface, but showing also much *iron* staining. As one proceeds along the cutting, the line begins to bend to the west, gradually traversing the beds more and more parallel to the strike, so that the beds on both sides of the cutting appear more or less horizontal in section, and occasionally gently undulating. Just before the line reaches its extreme western point and begins to turn sharply to the north again, the cutting attains its maximum depth of about 30 feet, and here will be noticed three or four perpendicular* masses of dark grey *massive* limestone, about 9 feet in width, in the face of the cutting, and sharply marked off from the intervening soft, reddish material. An observer travelling on the line the first time might take these outcrops for dykes, but on further inspection we can trace the bedding planes into the adjoining red rocks. Very likely these masses of dolomite were locally

* See photograph, Plate II.

Digitized by Google

richer in silica, and thus tended to be preserved in a fresher condition than the surrounding softer rock. Immediately before meeting the first of these occurrences the southern face of the cutting shows a broad syncline of red shaly rock, which probably represents one of those numerous cases also seen elsewhere, *e.g.*, along the Standerton Road, where the lowermost beds of the Pretoria series have been folded with the dolomite. Along the bedding and joint planes much iron staining has taken place, giving a red colour to the whole outcrop, but a fresh fracture shows a light grey appearance somewhat different from the usual appearance of the typical Pretoria shales. After passing the last occurrence of the vertical dolomite masses referred to, the cutting rapidly decreases in height, and shows a soft red, highly decomposed rock, until we reach the point where the line changes its course to the north-east and crosses a small spruit. All along this spruit, which closely follows the south-west side of the line, well exposed dip slopes of dolomite can be seen. Immediately after passing the spruit another cutting begins, less deep than the first one. The southern and lower face of this shows only dolomite, but the northern and higher one displays the two series. All along the lower portion of the latter face good exposures of fresh, dark grey, massive dolomite limestone with chert is exposed. These gradually pass above into dark red soil mixed with drift, consisting of small rounded pieces of black magnetic quartzite, evidently derived from the beds constituting the high ground of Schanskop to the north. Within the zone of red soil may be seen here and there a few bands of shale belonging to the Pretoria series, but it is impossible to say exactly where one series ends and the other begins, although by descending a short distance below the level of the line the dolomite is clearly seen, while on climbing to the top of the northern face of the cutting one meets with undoubted typical Pretoria shales. While the boundary between the two formations may thus be ascertained in a general way, it is impossible to fix the actual line, the impression being that the transition from the dolomite to the Pretoria series is marked by a series of passage beds showing thin intercalation of shales with the dolomite.* Between the points where the line crosses the little spruit alluded to and the Fountains numerous instances can be seen of minor foldings affecting the passage beds. One case is particu-

* See photograph, Plate III.

Digitized by Google

Dolomite with Interstratified Shales (Fountains).

Digitized by Google

Digitized by Google

larly clear, just before the railway reaches an embankment, where a sharp anticline followed by a syncline will be noticed. Other instances are displayed in two irregular cuttings in the slope on the north-western side of the line. These also show the development of passage beds, made up of iron stained shaly rocks, underlain by the more typical dolomite.

During the course of the writer's work in other areas, he has followed the base of the Pretoria series for some 17 miles to the south-east of the capital, and has in several cases found relationships between the dolomite and the lowest beds of the overlying formation similar to those displayed north of Ashbury. Analogous shaly passage beds were found about two miles north-east of Irene and elsewhere.

The second locality referred to above is Quagga Poort, where the normal sequence is complicated by faulting. If we make a traverse across the range a little to the west of the Fort in a northerly direction, we find on the crest of the ridge quartzites of the Pretoria series, dipping below and immediately succeeded by dolomite, making a very sharp contrast. This junction is, however, in reality a faulted one, owing to the occurrence of a main line of fracture, which runs very obliquely across the range.

The upper beds of the dolomite series show a preponderance of silica, which often gives rise to pure chert. This modification is well seen along the Old Standerton Road. The rock weathers to a dirty white colour, while on a fresh fracture it presents a compact bluish appearance. As one descends in the series, beds of purer dolomite appear; the frequent occurrence of fantastic forms of weathering, due to the unequal rate of erosion of the bands of silica and dolomite, forming a characteristic feature. A thin section of the true dolomite sometimes shows under the microscope alternately, bands composed of a clear quartz mosaic, and large crystals of dolomite. It is this alteration which gives rise to the so-called Oliphantsklip, the harder layers of silica weathering less rapidly and causing a series of ridges, the whole aspect bearing a general resemblance to elephant's hide.* The dip of the dolomite is to the north, but it is only occasionally that it can be recorded with accuracy. The outcrop generally consists of large rough

* For an illustration of this mode of weathering see Ann. Rep. Geological Survey, 1904.

Digitized by Google

blocks showing scarcely any sign of stratification. Within the limits of the map the two localities of Quagga Poort and the Fountains afford the best opportunities for measuring the dip.

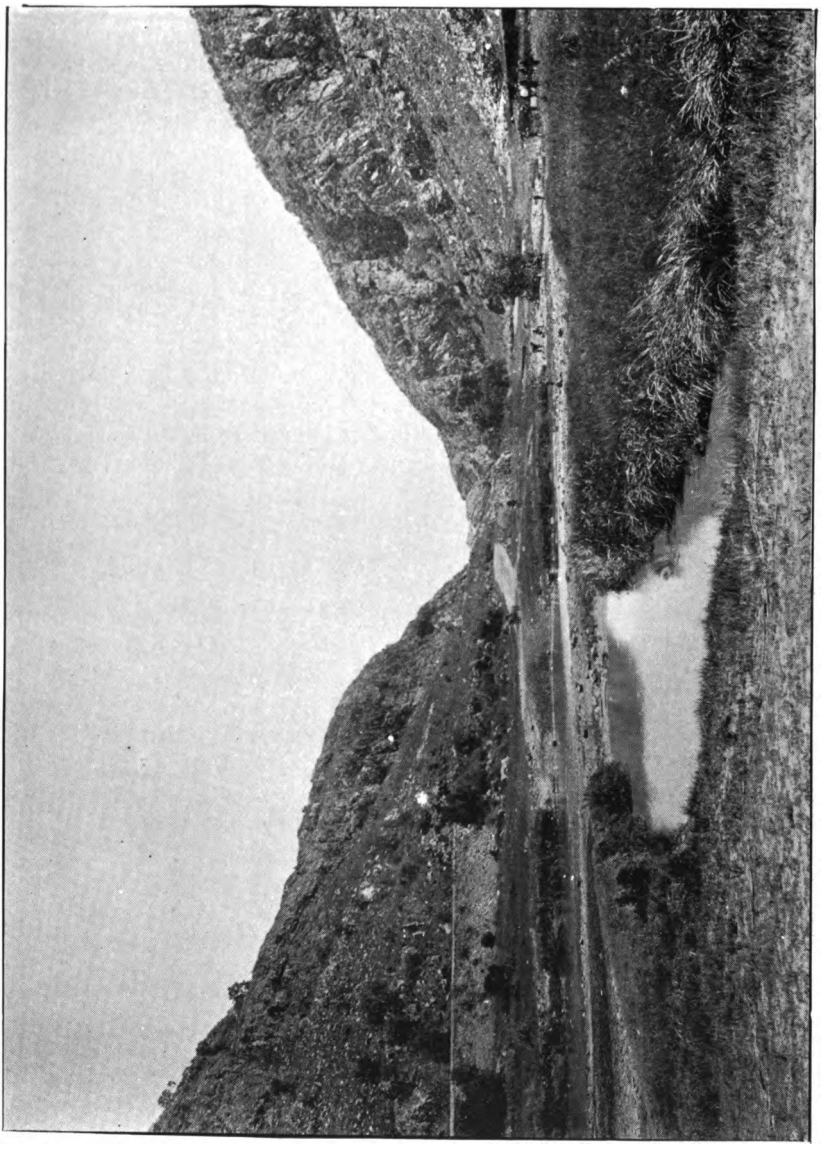
Owing to the presence of much calcareous matter the dolomite forms an important raw material for the manufacture of lime, but the economic importance of this rock is even greater in connection with the water supply.

The series has long been recognised as constituting the great water carrier of the country. Of the rain water, which falls on every given surface of dolomite, by far the greater part is removed by evaporation or by the run-off from the surface; only a small proportion actually percolates through the surface soil into the underlying beds. Thus the rate of infiltration has been shown—as a result of extensive observations—to amount to above 6 or 7 per cent. of the total rainfall. As soon as the percolating water reaches the harder rock below the surface soil, it enters the rock through the system of divisional planes, which may vary from bedding and joint planes down to the minutest fissures and cracks. The water being charged with carbonic acid derived from the atmosphere, and with organic acids contained in the surface soil owing to vegetable agency, gradually dissolves the more soluble carbonates of the dolomite. This action has continued for long periods, until the whole rock has become more or less honeycombed with underground fissures and channels. Where local circumstances are particularly favourable to this process of solution, large masses of rock are ultimately removed, with the consequent formation of caves, which act as a kind of underground reservoir. Such caves are well known in the dolomite, and occur in various localities to the south and south-east of Pretoria.* Occasionally they are found to be free from water, when they generally lie at no great depth below the surface. In such cases it is very probable that owing to denudation of the dolomite above the roof of the cave, the floor is now above the upper level of the zone of underground saturation.

The effect of this prolonged solvent action on the dolomite is reflected in the composition of the water issuing from the upper spring at the Fountains, which shows 52.2 parts of lime per million.

* See Ann. Report of the Geological Survey for 1903, page 41.

Digitized by Google



Wonderboom Poort.

Digitized by Google

Digitized by Google

The Pretoria Series.

The rocks belonging to this division of the Transvaal system comprise quartzite and shales. With reference to the underlying rocks, they show a conformable sequence. The shales, and in a few instances the quartzite also, are associated with a large number of intrusive sheets of diabase. The whole series constitutes by far the largest proportion—about 72 per cent.—of the various rocks occupying our area. From measurements taken west of Quagga Poort the thickness of the whole series, exclusive of the diabases, may be estimated at about 9,000 feet.

A.—The Quartzites.

While discussing the physical features in the preceding chapter, reference was made to the conspicuous east and west lines of hills formed by the hard quartzite, which, as the result of prolonged denudation, stand out above the softer shales. The map shows that one can recognise, omitting minor irregularities, seven lines of quatrzite hills. These are made up of three different quartzites; the most northerly and the most massive and conspicuous forms the Magaliesberg. It is succeeded on the south by the thinner and less striking Daspoort quartzite, which, owing to a system of faults, appears at the surface in three distinct positions, thus giving rise not only to the Daspoort Range, but also to the Meintjes Kop Range, the East Fort or Struben Kop Range, and the Lynwood Range. These four ranges are made up of beds belonging to one and the same horizon. Lastly we have the lowermost or Timeball Hill series of quartzites, which occur in three distinct positions. Firstly, it gives rise to the line of elevated ground which includes Proclamation Hill; secondly, there is the Timeball Hill Range proper, terminating in Muckleneuk, and thirdly, the Schanskop Range, on which Schanskop Fort and Klapperkop Fort are situated. These three ranges are made up of the same series, the repetition of which is due to the same faults which repeat the Daspoort Range. This will be discussed in the next chapter.

The Magaliesberg Quartzite.—The best opportunity of studying the character of this formation is afforded by an examination of the deep kloof in Wonderboom Poort. Here the observer will notice the massive, thickly bedded character of the rock, its excellent joint faces and regular dip of about 30° to the north. The weathered surface shows a somewhat rough and uneven character, and is

Digitized by Google

greyish-white in colour. Occasionally very good examples of ripple-marking can be found. On a fresh fracture the rock has sometimes a faint reddish appearance; in other cases the colour is faintly bluish, with a very compact texture. Specimens of the former type are easily procured from the railway cutting near the southern entrance of the poort. Standing in the main road about the centre of the poort and looking towards the north-east there will be noticed in the face of the cliff a large area consisting of a distinctly reddish rock, which shows only faint traces of bedding. Viewed from a point about 300 yards to the south, the appearance resembles that of a dyke, but closer examination shows that the material is quartzite. It is, however, rather coarser than the typical Magaliesberg quartzite, of a pronounced red colour, and contains much iron ore, together with well developed crystals of quartz. It is possible that this occurrence may be due to a fault or some other divisional plane, which has facilitated the circulation of waters holding iron in solution.

The southern slope of the Magaliesberg Quartzite forms an abrupt escarpment, followed at the base by a smooth and fairly steep slope of shales and diabase, while on the north side the slope is less pronounced, and corresponds more or less with the dip of the quartzites.

One may estimate the thickness of these quartzites at not less than 700 feet.

The Daspoort Quartzite.—In its general character this quartzite closely resembles that of Magaliesberg. The rock shows a similar colour, texture, and mode of weathering, but it differs from the upper quartzite in being considerably thinner—having a maximum thickness of not less than 250 feet, and in forming lower and less conspicuous features in the landscape. There are no intercalated shales, but along the foot of the range and separated from it by a thin series of shales runs a band of quartzitic ironstone (weathering to a black colour), and resembling at a distance the magnetite bearing bands of the Timeball Range. Although this layer of ironstone cannot actually be traced without interruption, there is little doubt that it represents a continuous band following the base of the main quartzite. It is well seen immediately below the quarries at the foot of Meintjes Kop, crops out here and there to the north of and along the eastern extension of Church Street, but is particularly well displayed in a conspicuous black escarpment to the south-east of Struben

Digitized by Google

Magaliesberg Quartzite (Wonderboom Poort).

Digitized by Google

Digitized by Google

Kop. It is represented on the map by a brown line immediately above a narrow intrusion of diabase. The outcrop of this ironstone band is often of great assistance in tracing the dislocations which have affected the Daspoort quartzite to the north end and east of Pretoria, for wherever the quartzite has been displaced, it is found that the ironstone band undergoes similar displacement with it.

Reference to the map will show that the various lines of hills over the centre of the area from west to east are indicated by a particular shade of yellow, which differs slightly from the tints adopted to the north and south. This plan serves to emphasise the fact that the Daspoort quartzite formations are but a series of four separate ranges. Thus, commencing at the West Fort, there is one range continuing due east across the Pietersburg line towards Villieria, reaching, after a slight displacement, as far as the neighbourhood of the Kilnerton Mission Station. The range here ends abruptly, but is found again at Meintjes Kop, whence it continues through Koedoespoort to the margin of the map on the east, after a slight break at the Hartebeest Spruit. The extreme end of this range of Daspoort quartzite lies about a mile beyond the eastern limit of the map. As before, so here it ends again abruptly, but is found again in the position of Struben Kop, and constitutes the East Fort range, terminating on the Willows No. 23, whence it is finally displaced into the position due east of the point where the Lynwood Road crosses Hartebeest Spruit. Beyond this point the Daspoort quartzite forms a continuous range extending at least 20 miles to the south-east towards the Bronkhorst Spruit. At the foot of each of these four separate ranges the ironstone band can be seen occupying a position with reference to the main quartzite exactly similar to that which is seen on Meintjes Kop.

The Timeball Hill Quartzite Series.—There are several distinctive characters which serve to mark off this series from the beds constituting the Magaliesberg and Daspoort Ranges. Whereas the latter consist of one massive sequence of hard quartzites with shales below and above, we find along any section across the Timeball Range a succession of thin quartzites from a few feet up to 12 feet and more in thickness, separated from one another by beds of shales, so that it will be more accurate to speak of a Timeball Hill quartzite series than of a single Timeball Hill quartzite.

Digitized by Google

In the first place some of these quartzites are highly magnetic, and weather to a deep black colour, so that the eye can easily follow their outcrops from some distance. Thus, on the northern slope of the Quagga Poort Range a distinct series of black lines and irregular patches may be clearly seen from the west end of the town. They represent the outcrops of the magnetic quartzite bands, of which one can recognise at least two—an upper one, very striking as seen from a distance, and a lower one, less conspicuous, trending more in a straight line along the summit of the range, and not well seen until one has ascended the ridge.

Frequently the slope of the hill coincides with the dip-slope of the upper band of magnetic quartzite, so that the latter is exposed as a broad black sheet, giving a striking appearance to the hill side. Where a gulley has been cut into the hill side the outcrop follows a more or less V-shaped course, as will be seen from an inspection of the map. In one place on the range due south of Skinner's Court will be noticed an almost complete circle of black magnetic quartzite ; this again is a result of unequal rate of erosion. The lower band lies much higher on the range than the upper, and, indeed, in a few places approaches the south side, so that it is not so much affected by the sculpturing processes of denudation, and crops out in consequence, as a narrow and undulating black band.

Leaving Skinner's Court and approaching Quagga Poort along the main road, we notice on our right on Proclamation Hill similar black quartzites. The range which terminates in this hill is considerably lower than the one further south, and is somewhat smooth and rounded. Here we can see that the magnetic bands are rather thin, fairly close together, and composed of a heavy black, rather lustrous rock. Specimens procured from a foot or more below the surface show dark red quartzite, the magnetic iron ore being indicated by a slightly black appearance. The upper and lower bands can be traced in a more or less continuous line from Proclamation Hill eastwards.

Proceeding from this point towards the south-west we soon reach Quagga Poort, which is of particular interest in connection with the behaviour of the Timeball Hill series. There are here at least four isolated areas of magnetic quartzite, quite out of their true position with reference to the sequence further east. The dip increases to

Digitized by Google

over 32°, while the strike changes through 90° within a distance of 200 yards. These displacements are due to a series of minor faults, associated with the main line of disturbance through Quagga Poort, and resulting in the formation of several small black koppies, on one of which stands a blockhouse.

Associated with the magnetite-bearing bands are thin white quartzites, which are well shown along a traverse from the Johannesburg Road Redoubt due north.

Unlike the other quartzitic formations, the Timeball Hill series of quartzites has a prevalent reddish colour, and very often the weathered surface of the rock is full of trough-like holes and depressions. The foot of the northern slope to the east of the Johannesburg Road Redoubt forms one of the best localities for examining the characteristic effect of weathering.

To study in detail the alternation of shales and quartzites which make up the Timeball series, it is well worth while to examine the railway cuttings of the Johannesburg line between the point where the Delagoa Bay line branches off and the Fountains Station. (See Section No. 3, Plate XIV.) Not only does the line traverse the series in the direction of the dip, but owing to a repetition by faulting one obtains two sections, one in a line with Timeball Hill, and the other further south at the foot of Schanskop. A few yards south of the Delagoa Bay junction the typical section of the Timeball Hill series commences in a low cutting exposing shales on its west side. These red shales dip at about 45° to the north, and as the cutting gets deeper, they are followed by the characteristic white massive quartzite, some 18 to 20 feet in thickness, and very sandy. As we proceed along the line to the south and thus descend in the series, we find this white quartzite underlain by a few feet of shales, and then by the uppermost band of magnetic quartzite, showing an increased dip of 70°, and a thickness of approximately 15 feet. Further to the south this band is followed by shales, and then almost immediately by the lower magnetic quartzite, dipping at 42°, and only some 6 feet in thickness. From this point onward we notice a succession of quartzites and shales; the former consisting of bands from 4 inches to 3 feet in thickness. The whole alternation of the two kinds of rocks are finally brought to an end by a red non-magnetic basal quartzite, 3 feet in thickness, dipping at 58° to the north. The position of this quartzite

Digitized by Google

marks the base of the Timeball Hill Range. A little to the west of the line a red clayey soil provides the material for some small brickworks, and quite close to the south side of these workings runs a small but definite outcrop of white dolomite—thus removed at least half a mile from the main mass of the same formation south of the Fountains Station. This interesting peculiarity will be referred to in the next chapter in connection with the Struben Kop fault. From this dolomite outcrop towards the south, the railway next takes us across a considerable thickness of shales, followed by a rapidly alternating series of thin quartzites and shales, similar to the succession further north, and terminating with an identical single band of red non-magnetic quartzite, 3 feet in thickness. Thus the general sequence of the beds to the north and to the south of the brickfields shows a striking similarity, with the exception that the two bands of magnetic quartzite are apparently missing. This point will be further discussed under the remarks regarding the Struben Kop fault.

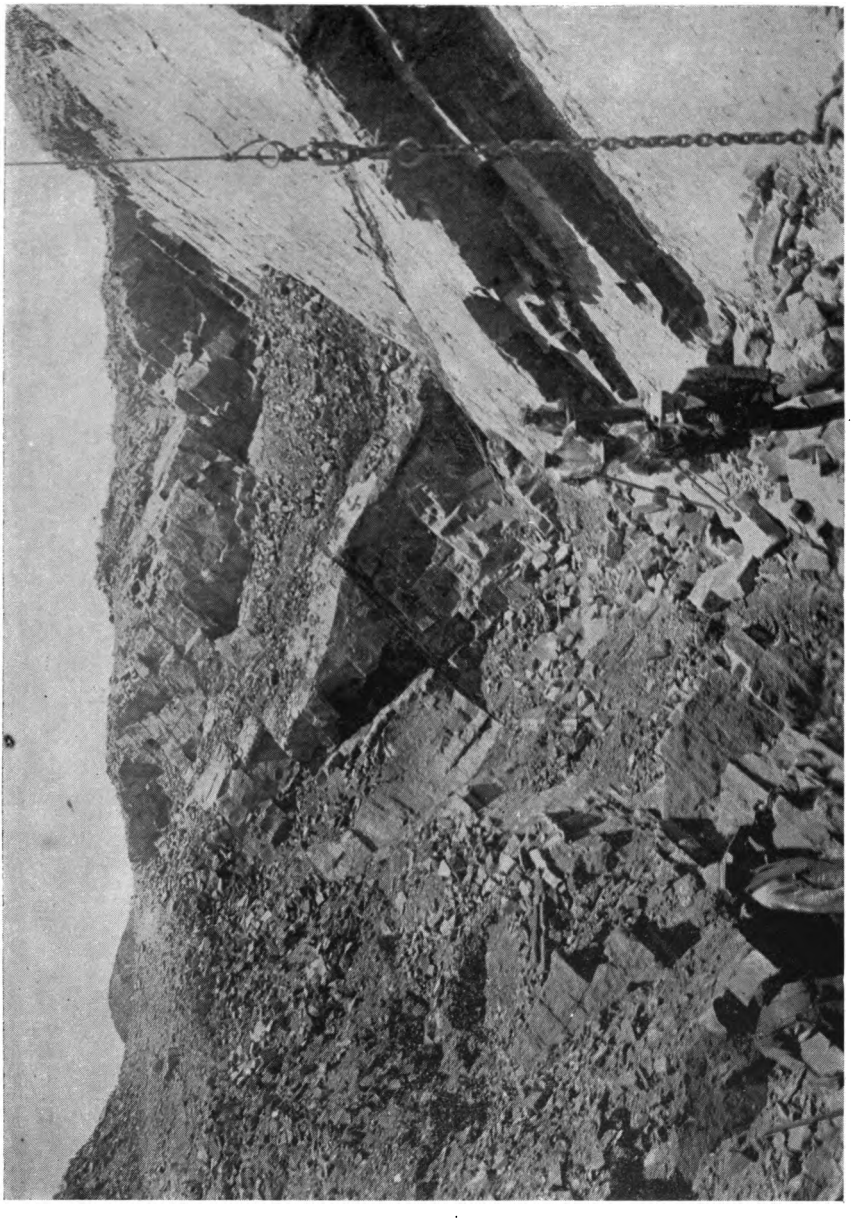
The vertical section Plate X. shows clearly the variable character of the Timeball Hill series.

B.—The Shales.

About one half of the area occupied by the Pretoria Series is made up of shales. These nearly always form the low lying ground, and it is only quite locally, that they give rise to a feature, as, for instance, when indurated through the influence of igneous intrusions.

The shales consist of a thinly bedded very fine grained soft rock, varying considerably in colour, the prevalent tint being pale grey to yellow, but red, purple, and black shades are not infrequent. The rapid variation in these shales can be very well seen along the track leading from the Standerton Road to Klapperkop Fort ; again all over the southern face of Struben Kop and in the quarries near Daspoort. One familar variety of a striped character and consisting of alternations of pale pink and green bands, occurs in close proximity to the northern edge of a thin diabase, which follows with more or less regularity the north side of the Timeball Range. It is again well shown immediately north of the small intrusion near the Proclamation Hill Range.

Digitized by Google



Quarry—South Slope of Meintjes Kop.

Digitized by Google

Digitized by Google

The dip of the shales is usually quite conformable to that of the quartzites, but since they are soft, thin, and often well jointed, the bedding planes near the surface usually show an inclination less than the true dip, which only begins to show itself a few feet below the surface. Numerous instances of this irregularity are shown along the cutting in the road which leads from the Delagoa Bay Railway Bridge at the head of Mears Street towards the Fountains.

The shales shown in the quarries at the foot of Meintjes Kop show a dip occasionally as high as 60°, and differ from the common varieties in being more of a graywacke type, somewhat less fine in texture and more quartzose. In the quarries (see Plate VI.) fine dip slope faces are seen, frequently with good ripple markings and sun cracks.

In certain places the shales below the Timeball Hill Range occur in the form of a fairly hard dark bluish rock, exceedingly well bedded, so as to form a kind of slate or flagstone suitable for economic purposes. The rock is, however, not a true slate, since there is only one set of divisional planes and this coincides with the original bedding planes. Localities where such slaty rocks occur are to be seen about half a mile to the east of the Johannesburg Road and a little to the south-west of Schanskop (see Plate XI.); again close to the right bank of the spruit, near the western boundary of Garstfontein; similar slaty rocks are found close to, and on the west side of, the Fountains Station.

The ease with which the shales adapt themselves to the frequent undulations occurring in the formation round Pretoria, can be seen in almost every cutting. Very excellent examples of such contortions are to be found in the section laid bare by a small spruit, which flows from the southern boundary of Waterkloof to join Hartebeest Spruit further north; anticlines, synclines, symmetrical and unsymmetrical, follow one another in rapid succession (see Plate IX.).

Similar folds, but of gentler character, occur in all the slate quarries alluded to, while to the west of the town between Proclamation Hill and the Racecourse are seen marked reversals of the normal northerly dip (see map); these latter are due to the effects of the Meintjes Kop fault.

Digitized by Google

Igneous Rocks.

Norites.

The rocks classified under this head are confined to a narrow belt north of the Magaliesberg Range. Their southern limit is not easy to define, as the rocks shade off gradually into diabase, through loss of hypersthene and other accompanying characteristics.

The typical fresh norite shows the characters of a hypersthene gabbro, the predominant colour being light gray. A macroscopic examination shows the presence of white plagioclase and gray hypersthene, generally about equal in proportion. On the whole the rock is very fresh and shows considerable variation in texture, from medium grained to very coarse with occasionally crystals of the ferromagnesian constituent half an inch and more in length. In several places a distinct tendency to banding is seen as in the excellent outcrops below the railway bridge over the Aapies River, while a little to the north of this point, where the norite gives rise to the striking koppies known as the Pyramids on Onderstepoort, this banding possibly accounts for the bedded appearance seen in the face of the hills.

Very characteristic is the mode of weathering, giving rise to more or less smooth rounded boulders dark brown on the surface.

Under the microscope the norite shows the characters of a coarse holocrystalline plutonic rock with hypidiomorphic structure. The minerals recognisable are plagioclase, diallage, and hypersthene, the two latter being frequently intergrown. Besides these essential constituents there are a few accessory minerals, such as apatite, magnetite, pale green hornblende, and traces of biotite. The high symmetrical extinction of the felspar points to labradorite or anorthrite, which forms the bulk of the rock in large tubular crystals. These, in some cases, have crystallised before the ferromagnesian constituent, as is shown by an occasional tendency to ophitic structure in the diallage with regard to the plagioclase. The former is readily identified by its brownish colour, high refraction circles, bright interference colours, and the characteristic well-marked cleavage. The second ferromagnesian constituent hypersthene, builds large irregular crystals, frequently enclosed in the diallage and showing faint pleochroism. They are largely traversed by irregular

Digitized by Google

cracks, while at the margin they pass into secondary very pale green hornblende.

Mention was made above of the fact that the southern boundary line of the norite cannot be accurately fixed. This is due to the rock shading insensibly into diabase, so that one is forced to the conclusion that both types originated by differentiation from the same igneous magma. When traced to the south the rock assumes characters more and more like that of a true diabase, hypersthene being absent, optitic structure more marked and the texture more fine grained, while to the north the characters of the gabbro type become more marked, until we finally reach the red granite east and a little south of Waterval Station.*

Diabases.

The very numerous occurrences of this type of intrusive rock in the shales and to some extent in the quartzites form one of the best known features of the Pretoria Series. The diabase forms numerous more or less thin sheets, which have been intruded into or between the beds of shale, the nature of the latter being such as not to offer any great resistance to such intrusions. As a consequence their outcrop forms a series of belts, the strike of which is identical with that of the shales, the width varying only slightly for the same intrusion. On the map will be seen some twelve of such diabase sheets. Some of these continue for a considerable distance, others appear to die out or come to an abrupt termination against a fault, as is also the case with some of the quartzites. Nearly always the weathering of the rock results in the formation of a thick deposit of red soil, which often renders it difficult to follow these sheets continuously at the surface. In the town area, where outcrops or indications are often altogether wanting, the information obtained from boreholes has been most useful in the mapping out of some of these diabase sheets.

The thickness of the sheets varies considerably. There are some diabases only a few feet across, others reach a thickness of 500 feet or more, but it must not be forgotten that some parts of the area, especially in the south-east of the map, have been subjected to much undulation, giving rise to an exaggerated thickness.

* For further details of the norite and the literature bearing thereon, see Annual Report for 1903, pages 31 and 36.

Digitized by Google

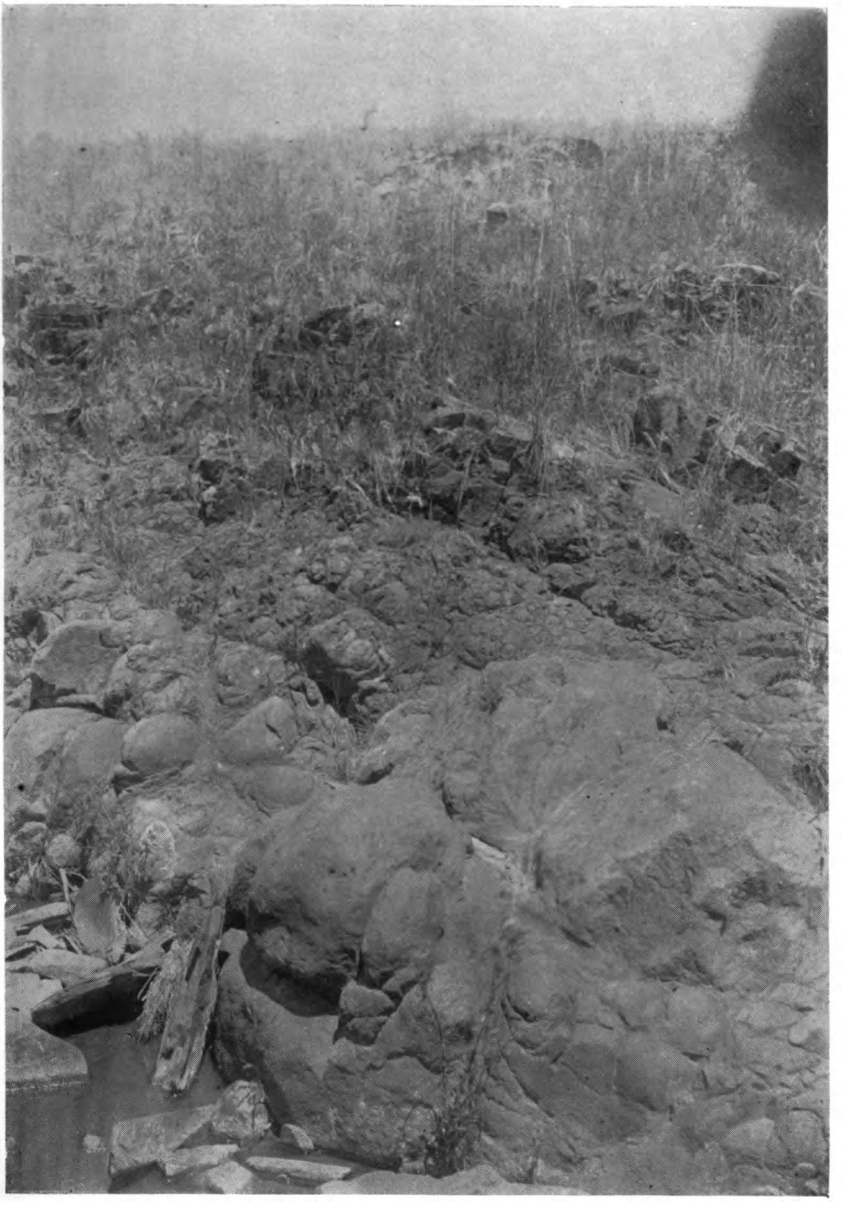
Taking any one sheet, it is found that there is little variation in this respect, a sudden change of thickness being occasionally noticeable in the same sheet, where displaced by faulting, as will be seen along the fault, passing through Hartebeest Poort with a southerly curvature, where it approaches Erasmusdam.

That the diabases are intrusive rocks and do not represent contemporaneous lava flows follows from several reasons. The marked persistence of the sheets laterally through considerable distances, together with the fact, that many instances occur, where a diabase alters the sedimentary rocks both above and below, points to their intrusive origin. Furthermore, they represent a distinct petrographical type, such as is not found in an effusive rock ; there is no flow structure, no glassy residue, and no minerals characteristic of true volcanic rocks, while, on the other hand, all the characters point to a slow cooling under pressure with resultant holocrystalline and hypidiomorphic structure.

The commonest mode of metamorphism produced by the intrusion of the diabase into the shales is that of baking or hardening, in consequence of which the usually soft easily eroded shales have been converted into a hard, sometimes bluish, rock, which in connection with the more important diabases may form a distinct feature in the landscape. This is well shown above the Timeball Hill quartzite, on Garstfontein, and on the west of Proclamation Hill. Again all round the Leper Asylum, as well as a little south of the Daspoort cutting, and in many other places.

The results of weathering in the diabase are very characteristic. The long exposed surface of the rock is usually dark brown, contrasting markedly with the prevalent colour of the quartzites. The blocks of diabase, scattered irregularly over the surface, have a strong tendency to assume spheroidal forms; a feature well shown on the southern face of Meintjes Kop, where rounded blocks of considerable size occur. When a diabase has not been very long exposed, the initial stages of this process are particularly well seen in the formation of numerous well rounded spheroids, varying from a few inches to over a foot in diameter and often made up of several concentric shells. Such a case is very clearly demonstrated by several thin sheets which are exposed along the spruit cutting across the north-west corner of Garstfontein (see Plate VII.).

Digitized by Google



Spheroidal Weathering in Diabase (Waterkloof).

Digitized by Google

Digitized by Google

As a result of prolonged weathering, outcrops of the rock gradually disappear and are replaced by a thick deposit of bright red highly ferruginous soil, generally very fertile and contrasting markedly with the pale yellow soil derived from the decomposed shales. The passage between the latter and the deposit due to the igneous rock is sometimes very sharp and affords material assistance in tracing the line of junction.

The surface of a freshly broken typical diabase is usually pale greenish blue in colour and shows a firm compact to medium-grained structure. Taking the intrusion as a whole, there is little variation in the microscopical characters, the differences being merely those of colour and texture.

There are, however, two sheets which vary in some respects from the typical characters of the diabase and deserve special mention. The first of these is a thick intrusion between the Daspoort and Timeball Hill Quartzite, extending from the Leper Asylum to Meintjes Kop, displaced from there to a point a little west of Proclamation Hill, whence it continues through Arcadia across the Delagoa Bay line to north of Struben Kop. There it is again displaced towards the south-east, appearing again on Uitval and continuing thence to just beyond the main drift at Lynwood, where it suffers a final displacement to the south-west, which brings it through Garstfontein in a south-easterly direction below the main Daspoort Range. In the eastern portion of our area it appears to be much thicker, but this is no doubt partly due to the undulating character of the ground. This diabase differs from the others in being of a pronounced vesicular structure, and showing numerous more or less rounded amygdules of nearly opaque white quartz, the central core of which very often still shows a transparent and glassy appearance. These amygdules vary from half an inch in diameter to microscopical dimensions, and sometimes show a very thin peripheral layer of another mineral, possibly chlorite. The weathered surface is as usual dark brown and somewhat pitted, while the blebs of quartz stand out in the form of round rusty brown to white knobs. Wherever this particular diabase has been much weathered, the thick red deposit derived from it presents an appearance somewhat like a gravel owing to the numerous pieces of quartz having survived the disintegration of the parent rock. In addition, the rock shows a small amount of copper pyrites.

Digitized by Google

All these appearances are well seen over the Uitval outcrop, along the north-east boundary of Garstfontein and in a small but good exposure in Arcadia, where Schoeman and Park Streets run close together.

This same vesicular diabase has been further traced by the writer some 18 miles to the south-east, where it occupies a strictly similar position with reference to the overlying Daspoort quartzite.

The second variation from the normal type occurs in a thin intrusion about half a mile to the south of Quagga Poort and at the junction between the Pretoria Series and the dolomite. It is rather coarse, of a uniform dark greenish colour, with conspicuous needle-shaped crystals of augite up to one inch and more in length, which stand out well on the weathered surface.

Apart from these two variations, there is sometimes seen a slightly developed spherulitic structure, for instance, among the diabases on Rietfontein No. 24 north-east of Pretoria.

In addition to those in the Pretoria Series, there are also occasional intrusions in the dolomite, such as in the south-west corner of the map close to Hennops River. The rock found here behaves like a dyke and trends south-south-west and north-north-east. It has a breadth about 20 feet and differs in character from the typical diabase further north. In colour it varies from red to grayish green, the former variety showing greenish spots of a decomposed ferromagnesian constituent. The fresher portions of the rock bear some resemblance to a gabbro-like intrusion occurring close to Pinedene Station, near Irene.

The essential minerals present in the commoner diabases are augite and plagioclase. These minerals, however, are rarely fresh, the former being converted into very pale green compact hornblende and the latter so crowded with secondary products that a specific determination of the plagioclase is generally impossible.

The Volcanic Breccia and Felsites of Derdepoort.

Within and a little to the south of Derdepoort there occurs a volcanic eruptive breccia, which has broken through the quartzite of the Magaliesberg and the diabase and shales underlying it. Associated with this rock are two small outcrops of dark reddish to purple compact

Digitized by Google

felsite, one lying close to the breccia, the other about three-quarters of a mile north of Silverton.

In addition to the breccia at Derdepoort, a small elongated mass of a very similar rock was found on Kameeldrift No. 521, piercing an irregular mass of quartzite of the Magaliesberg type. These igneous rocks are very similar in character and can thus be dealt with together. They consist of a coarse greenish red breccia, in which angular fragments of reddish quartzite predominate. These are sometimes accompanied by pieces of decomposed green diabase, good examples of which are particularly common over the south-west part of the Derdepoort outcrop. Towards the north the breccia sends out a narrow tongue which extends across the Hartebeest Spruit, and here washing operations have recently been carried on with a view of testing the possible diamondiferous nature of the rock. The centre of the poort is marked by a small rounded kopje over which the junction between the breccia and the quartzite is rather sharp. Much of the rock to the west of this kopje shows irregular vein-like bands of calcareous matter, permeating it. These portions are black on the weathered surface and sometimes studded with small sharp crystals of quartz, while the fresh fracture shows calcite of a bright reddish colour. The origin of these calcareous portions is somewhat doubtful. They may possibly represent portions of dolomite brought up from some depth, but it is more likely that they represent the result of changes induced by the agency of deep seated circulating waters charged with carbonate of lime.*

Like the breccia, the felsites bear no apparent relation to the behaviour of the adjoining sedimentary rocks. They resemble in general appearance those felsitic rocks which are so common a few miles further north, but the exposure near Silverton differs in being purplish in colour and rudely spherulitic in structure.

These particular igneous rocks must be of an age subsequent to that of the diabase and may very likely owe their origin to those powerful movements which will be discussed in the next chapter.

---

* See Annual Report Geological Survey for 1903, p.p. 34, etc.

Digitized by Google

CHAPTER III.

THE GEOLOGICAL STRUCTURE.

General Remarks.

The neighbourhood of Pretoria shows a geological structure which, at first sight, appears rather complex; but on closer examination it is seen to result from a system of earth movements, which follow one general *modus operandi*. Before proceeding to discuss in detail the structural irregularities shown in the sequence of the beds, it will be profitable to consider the nature of the various formations from the point of their adaptability to yield to, and show the result of, a system of dislocating stresses.

We may, from this point of view, divide the rocks into two groups: firstly, the hard rocks, comprising the dolomites, quartzites, and diabases; and, secondly, the soft rocks, comprising the shales. The latter are nearly always thinly bedded, well jointed, and soft, so that they would easily yield to and adapt themselves to any crust movement; furthermore, even under ordinary circumstances, they show many irregularities in their mode of arrangement; hence we must not look among the shales for any interpretation of the nature of the records of displacement. On the other hand, rocks like quartzite and, to some extent, diabase, consisting of very much harder material, should readily preserve the effects of earth movement, particularly the results of fracturing. Thus, the uppermost or Magaliesberg quartzite, which consists of a great thickness of a practically massive rock, would probably not show much disturbance, except a general bending of the strike, and in the poorts a slight lateral shifting. On the other hand, the Daspoort quartzite consists of a much thinner development of similar rock. It is, therefore, probable that it should show more marked lateral shifting. Finally, the effects on the Timeball Hill Quartzite Series should be most pronounced of all, for it does not consist of a single band of quartzite, but in reality, to a considerable extent, of shales, so that the few thin harder beds of quartzite should serve to record

Digitized by Google

any motion, while the preponderance of soft rock should enable the series, as a whole, to yield easily to earth movements, whether resulting in folding or fracturing, accompanied by lateral shift.

The above theoretical considerations are fully borne out by the field evidence. Even a casual inspection of the map shows this. The Magaliesberg quartzite shows practically a continuous course; the Daspoort quartzite forms at least four separate ranges,* and has a maximum lateral displacement at the surface of about eight miles. Finally, the Timeball Hill Series shows, in addition to three ranges with a maximum lateral shift of about seven miles, an extraordinary amount of folding, minor faulting, and general buckling, especially in the south-eastern portions of the area. In connection with the lowermost quartzite series, the occurrence of the magnetite bands is particularly fortunate, for it enables one to trace very closely the nature of the movements, as they affect this series.

With regard to the dolomite, there is very little direct evidence to be seen—excepting the neighbourhood of Quagga Poort—of any faulting, since this series is confined mainly to the south-western and undisturbed portion of our area; and, moreover, the nature of the formation would render it difficult to detect displacements which might occur in it. The presence of two elongated anticlinal domes of dolomite on Garstfontein shows, however, that the movements have affected the lower series as well. [See Section No. 1, Plate XIII.]

The geological structure may be briefly stated as follows:—The Dolomite and Pretoria Series originally had a uniform and conformable northerly dip, and their normal sequence was very much like what it now is in the extreme West beyond Quagga Poort. Subsequently a series of disturbances took place, resulting in the formation of a number of lines of dislocation, whose general direction is from north-east to south-west. These fractures broke through the whole sequence of strata, splitting the area up into a number of belts of country, which were shifted

* The writer would call attention to the necessity of distinguishing between such expressions as Daspoort Quartzite and Daspoort Range; the latter has a purely geographical significance and cannot be extended beyond the limits of the topographical features which it denotes; the former signifies a certain formation occupying a definite geological horizon, which has no necessary connection with geographical position.

Digitized by Google

relatively to one another along the fault lines and in a south-westerly direction. Their effects being more marked in the harder rocks, the result now seen is the constant repetition of the Daspoort and Timeball Hill quartzites, together with the intrusive diabases. These movements were accompanied by a bending of the whole of the formations at a point lying to the north-east of Pretoria, in the neighbourhood of Franspoort; north-east of Hatherley. In consequence of this change of strike, the dip over the south-eastern part of the map tends to assume a north-easterly direction.

Numerous cases all over the world are now known where such movements have been accompanied by eruptive forces and a change in the resultant physical feature, tending to raise the general level of the area affected. It is, therefore, in this connection of particular interest to find an eruptive breccia cropping out at Derdepoort in close proximity to the highly disturbed district, while the occurrence of relatively much higher ground a little to the south of Pretoria was already commented on in the Chapter on Physical Features. This matter will be again referred to in connection with the main lines of dislocation.

In the following pages these movements and their results are described in detail, and occasional reference will be made to areas lying outside the limits of the map, but only in so far as the information thus obtained helps to throw further light on the structural problems, we are immediately concerned with.

Main Lines of Dislocation.

Out of a total of some twenty-five faults seen in the neighbourhood of Pretoria, there are three which have produced a most powerful effect on the original structure, and at the same time continue for a distance varying from five to eighteen miles. These main lines of dislocation will be now described.

(1) *The Meintjes Kop Fault.*—This fault extends completely across the map in a direction from east-north-east to west-south-west, and can be traced over a total distance of not less than sixteen miles. Within our present area its first effect is seen in the displacement of the first main diabase lying to the north of the Daspoort Range, and about a mile to the east of the Kilnerton Mission Station. The abrupt change from dark red

Digitized by Google

diabase soil to the pale yellow shaly soil is very marked, and allows of an accurate limitation of the fault line. Proceeding about half a mile to the west of the Mission Station, we find that the Daspoort quartzite, after having followed a practically continuous course from the Leper Asylum due east for some twelve miles, comes to a sudden termination against the fault, and is displaced along the line of fracture over a distance of two and a half miles, until it occupies the position now marked by Meintjes Kop, half a mile due south of the main Daspoort Range. Such a movement would very likely be accompanied by a certain amount of elevation of the shifted beds. As a matter of fact, the summit of Meintjes Kop has an elevation of 4,712 feet, and is 100 feet above the level of the quartzite, which has remained in its original position. During its further course from Meintjes Kop the fault passes through the low-lying northern part of the town, thence by the north-westerly corner of the Racecourse towards Proclamation Hill, cutting off and displacing, in a manner strictly analagous to that described above, at least three further diabases. On reaching Proclamation Hill, it cuts through the Timeball Hill Quartzite Series, and places it in a new position a mile and a half further south-west. It is necessary to point out that the series of Timeball Hill quartzites at this point, *i.e.*, half a mile north-east of Quagga Poort, does not form a very conspicuous feature, but an examination of the ground soon shows, that the line of hills, including the Timeball Hill, though actually terminating due south of the Lunatic Asylum from a topographic point of view, can be traced continuously to Quagga Poort, ending against the Meintjes Kop fault at the point indicated above. The fault now enters Quagga Poort, and crosses the main range to the west of the poort in a very oblique manner, and is finally lost sight of in the main area of the dolomite.

The close study of the mode of arrangement of the formations in and around Quagga Poort constitutes one of the most interesting and instructive object lessons to the student of structural geology. It is only possible here to briefly indicate, what can be far more clearly seen than described. An observer standing on the high ground, say, about midway between the Leper Asylum and the Daspoort cutting will, on looking to the south, receive the impression that there is only one range extending from behind the Station due west to Quagga Poort, when, as

Digitized by Google

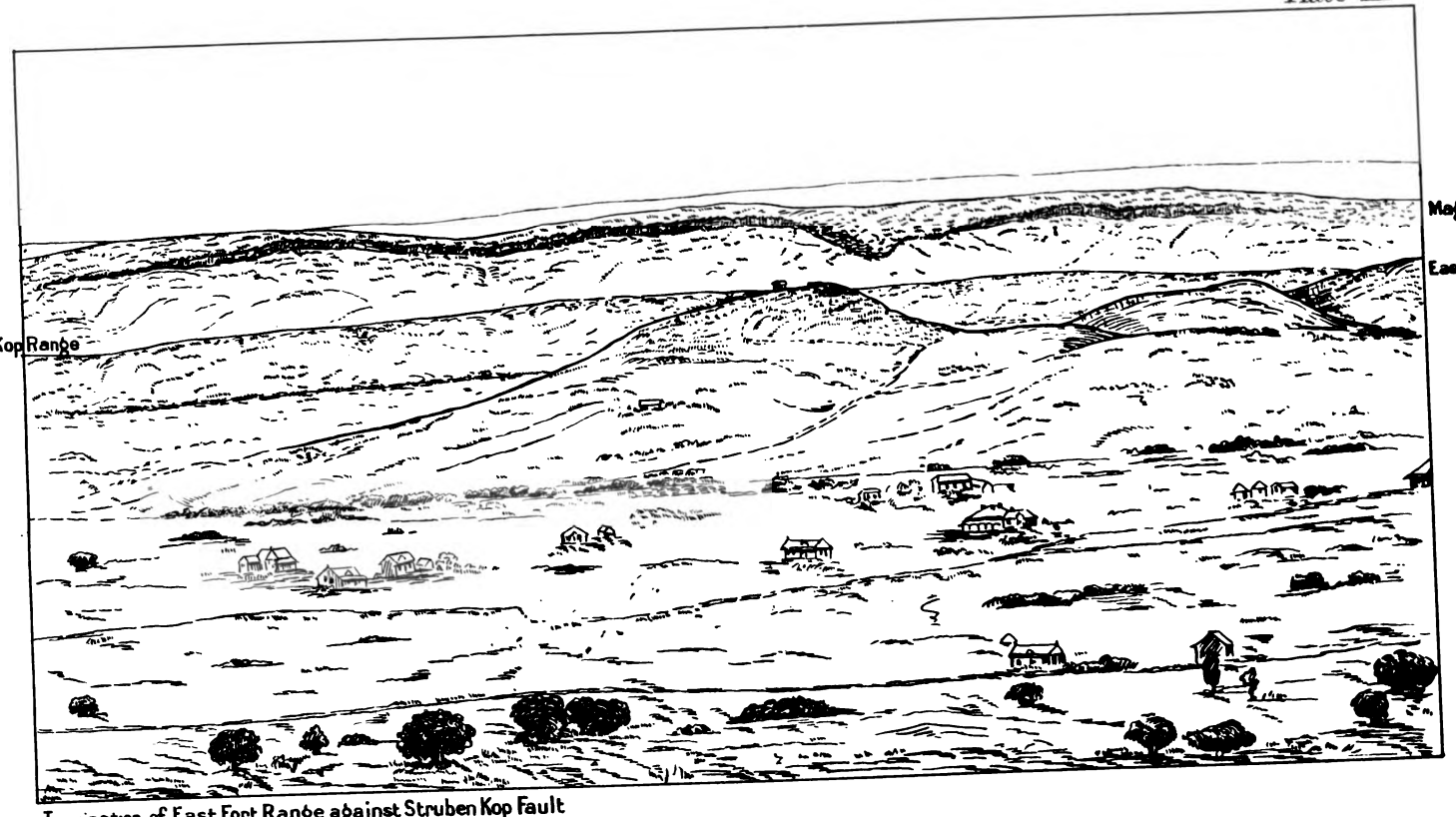
a matter of fact, there are two ranges, both of approximately the same height. But while the northern one, the Timeball Hill Range proper, rapidly dies out south of the Lunatic Asylum, the southern or Schanskop Range takes its place in the line of sight, so that the impression of a perfect continuity is received. Looking a little to the east, the observer will notice the very sinuous course of the black magnetite quartzite outcrops, while along the same range, to the west of Quagga Poort, these characteristic curved lines are not to be seen. This may lead him to anticipate some change in the formations, which make up the line of hills. On examining the range closely, we find that from Schanskop to Quagga Poort it is composed of the Timeball Hill Series, but that immediately beyond the poort its northern face shows dolomite, while the southern face is still made up of the Quartzite Series. This is entirely due to the very oblique course which the Meintjes Kop fault takes; so that for a short distance it runs along the crest of, and parallel to, the line of the ranges. The sharp juxtaposition of the two formations, and the consequent inversion of the Pretoria Series below the dolomite, can be best studied a few yards to the west of Quagga Poort. Here the fault line over a distance of at least 200 yards can be fixed to within five feet.

(2) *The Struben Kop Fault.*—In its general effect on the sequence of the beds this fundamental line of fracture resembles the Meintjes Kop fault. Originating somewhere in the neighbourhood of Hatherley, the second main fault enters the area of the map about 100 yards north of the meridian line 25° 45′. About a mile before reaching the extreme east of our area, this fault cuts through and shifts the range, which begins at Meintjes Kop,* and brings it into its present position at Struben Kop. This movement must have involved a displacement along the fault plane of some seven miles. Thus the Daspoort Range, which, through the agency of the Meintjes Kop fault, was displaced into the position now indicated by the belt of high ground stretching from Meintjes Kop to the east, was, through the Struben Kop fault, further displaced into the position of the line of hills commencing with Struben Kop, and extending to the Willows, beyond Hartebeest Spruit. Practically, this

* On the map, which the present memoir is intended to accompany, this effect does not appear, but it is shown in the map accompanying the Annual Report of the Geological Survey for 1904.

Digitized by Google

Plate VII



Termination of East Fort Range against Struben Kop Fault

Digitized by Google

Digitized by Google

second dislocation represents a strike fault as far as Struben Kop, but from this point it follows a course more resembling that of a dip fault. The next marked effect of the Struben Kop fault is to cut off the Timeball Hill Range proper, which was already shown to represent the continuation of the series of quartzite now terminating in Proclamation Hill on account of the Meintjes Kop fault. When we next look for the broken end of the Timeball Hill Range, we shall find that the whole series of quartzite, marked by Schanskop and Klapperkop, have been pushed to the west along the plane of the Struben Kop fault as far as Quagga Poort. Thus, the geological continuation of the Timeball Hill Range, where it suddenly ends a little east of the Howitzer Redoubt on Muckleneuk, lies about half a mile to the south and some eight miles to the west, that is to say, at Quagga Poort. At first sight, this result may seem startling, but there is abundant evidence that the earth movements—in particular, as affecting on the Timeball Hill Series—must have been very powerful, and, moreover, the far-reaching character of the disturbances is supported by evidence obtained from other regions within the area affected.

The influence of the Struben Kop fault upon the igneous rocks is strictly analagous to that of the Meintjes Kop fault, for we find it cutting off and displacing the same diabases ; the resultant effect being easily seen, since the principal sheet displaced is made up of that particular amygdaloidal variety of rock described above.

From Quagga Poort to Muckleneuk this fault runs in the depression lying between the two belts of the Timeball Hill Series, but since we have here only shales, the exact course of the fault line is not so easy to ascertain ; a thorough search, however, over the ground occupied by the extensive plantation on Groenkloof, north of Klapperkop, afforded valuable evidence in the termination of the two thin diabases, which here lie above the Klapperkop Range.*

On the other hand, from Muckleneuk to Struben Kop the fault line is capable of accurate limitation, owing to the good outcrops and the variety of rocks involved, which may be readily seen by traversing from the Military Hospital at Rissik along the main road towards the east.

---

* Excellent records of the powerful effect of this fault are seen in the contorted shales on the southern edge of the clay pit, belonging to the Fountain Grove brick factory.

Digitized by Google

If the effect of the Struben Kop fault on the Timeball Hill Series has been, as above indicated, we should expect to obtain further confirmation, firstly, by observing whether the general sequence of beds is identical across Timeball Hill and across Schanskop; and, secondly, by noting, if there is any decided difference in the mean elevation of the displaced, as compared with the original, position of the range; for it is probable that such an amount of lateral shift would have been accompanied by some amount of uplift. The answer to the last line of investigation has already been given in connection with the physical features. Thus, Meintjes Kop is considerably higher than its geological continuation a little west of the Kilnerton Mission Station. Still more marked is the contrast between Klapperkop, 5,085 feet, or Schanskop, 4,994, in the displaced position and the Howitzer Redoubt, about 4,600, in the relatively normal position.

In order to settle the first question, an accurate measurement was made along the railway cutting between the Delagoa Bay junction and a point just south of the series constituting the Schanskop Range. The main results have been already given in connection with the descriptive geology of the Timeball Hill Series.*

If the reader will examine the Section 3 on Plate XIV., he will find a close resemblance between the general sequence of the beds north and south of the point marked by the brickfields. While there is a regular repetition of the beds immediately succeeding the basal quartzite of the Timeball Hill Series, the upper beds, such as the two magnetite quartzite, are missing over the Schanskop part of the section. Furthermore, there is a peculiar occurrence of dolomite right in the Pretoria Series. It may be briefly shown, however, that these apparent anomalies are fully accounted for by the behaviour of the Struben Kop fault. Although the two magnetic bands are not seen along the railway cutting in the south part of the section, if we ascend the north slope of Schanskop we shall soon find them in situ. But between this point and the railway level they were met by the plane of Struben Kop fault, dipping to the north (see section referred to), so that all the upper beds are cut out by the fault. If we could fill up the whole valley by the material which

---

* See Chapter II., page 30.

Digitized by Google

Contorted Shales near Lynwood Fault (Waterkloof).

Digitized by Google

Digitized by Google

has been removed by denudation, and take an imaginary section from a point just below the summit of Timeball Hill along a horizontal line towards Schanskop, the whole series of the Timeball Hill quartzites and shales would be regularly repeated.

With regard to the peculiar dolomite occurrence, if the reader will refer to the map he will notice a short wedge-shaped outcrop of this formation crossing the railway, where the Aapies River forms a sharp bend, midway between Timeball Hill and Schanskop. Now, before the full effect of the Struben Kop fault had taken place, and before the Schanskop Range had come into its present position, the shales underlying Timeball Hill must have in due course been followed by the dolomite, so that the small outcrop near the Aapies River bend referred to, represents the upper boundary of the dolomite in the position, where it normally came in, before it was affected by the Struben Kop fault. Thus, the apparently anomalous position of this strip of dolomite helps to confirm the nature of the main line of fracture, which must clearly coincide with the extreme southern limit of this outlying patch.

(3) *The Lynnwood Fault.*—The third main line of dislocation arises as a branch of the Struben Kop fault to the east of Hartebeest Spruit. Its first effect is to cut through the quartzites of the Struben Kop Range on the western boundary of the farm The Williows No. 23 ; the same strata are found again on the farm Haartebeestpoort No. 304, about one-third of a mile east of the drift at Lynnwood, whence they continue, without any further marked interruption, to the south-east, at least as far as Bronkhorst Spruit. Simultaneously, the fault causes the main vesicular diabase to terminate abruptly a short distance east of Hartebeest Spruit. This intrusive sheet, being well exposed along its entire course, the sudden transition from diabase to slate is very striking, particularly where the main road ascending from the Lynnwood Drift towards the east reaches its highest point. There are, moreover, at least four other diabases, affected in a like manner, while the displacement of the ironstone band, very well seen all over Hartebeestpoort, is equally conspicuous. A little to the south-west of Hartebeest Spruit, the Lynnwood fault begins to turn towards the south as one approaches Erasmusdam, and probably

Digitized by Google

has helped to form the somewhat deep gorge through which the spruit now flows. If this stream be closely examined, there will be found in its bed several points, where the effect of the fault on the slates is very striking. Thus, a little over half a mile due south of the extreme easterly beacon of Waterkloof No. 29, the well-bedded shales of the stream bed show, in addition to the usual undulations and more or less sharp contortions, a very sudden and considerable change of dip and strike ; there can be little doubt that such points must lie very close to, if not actually along, the line of the Lynnwood fault. Near the point referred to, the main fault cuts off the series of Timeball Hill Quartzite, which are succeeded on the west by a shale valley, until they appear again over a fairly large completely isolated hill trending north and south.

The Structure of the Timeball Hill Series and Dolomite South-East of Klapperkop.

No locality within the limit of the map shows more clearly the powerful earth movements to which the neighbourhood of Pretoria has been subjected than the quartzite and shales of the Timeball Hill Series in the south-eastern area, on Groenkloof, Waterkloof, Garstfontein, and Erasmusdam. The disturbances in this region particularly, have repeatedly brought the softer shales against the harder quartzite, and this fact has resulted in a somewhat complex structure, which is well displayed by the highly eroded surface and well worth closer study.

In connection with the remarks made above with reference to the Lynnwood fault, the occurrence was mentioned of an isolated portion of the Timeball Hill Series, which is of particular interest. We find, in fact, over the area lying within a one-mile radius of the western beacon of Waterkloof, two deep gulleys, running approximately north and south, both marked by fault lines—the more easterly being the Lynnwood Fault, the more western a subsidiary line of fracture running parallel to the major fault, but not traceable so far north. These lines of fracture have broken through all but the lowermost quartzite of the Timeball Hill Series, with the result that the remainder of this series now forms a completely isolated hill, whose strike shows, moreover, that this de-

Digitized by Google

tached portion has been turned bodily round through some 45 degrees in virtue of the same movements, which have caused the duplication of the Timeball Range between Muckleneuk and Quagga Poort; so that, on ascending the summit of this hill, about 150 yards north of the south-western beacon of Waterkloof, we find ourselves surrounded by valleys.

The dip of the Timeball Hill Series on Timeball Hill is somewhat high, and varies from 42° to 60°; at Klapperkop it is probably not more than 40°, while further to the south-east it becomes considerably less, and over a portion on Erasmusdam, represents only the lowermost band of outcrop; and as shown on the map, is much wider than in the neighbourhood of Klapperkop. In addition to having a low dip, the formations in the south-east are thrown into a series of anticlines and synclines, as shown in Section No. 1, Plate XIII., and these have affected, not only the Timeball Hill Series, but the uppermost beds of the underlying dolomite as well. It follows, that the narrow strip of quartzite seen to the north-east of the Old Natal Road, on Erasmusdam, represents only the lowermost band of the series, which dips at a very low angle towards the north-east. It forms in reality a portion of a syncline, followed by an anticline of shales, which has also brought up the dolomite over a kind of lozenge-shaped outcrop, on which the homestead of Erasmusdam is situated. Further to the north-east the beds again dip normally, away from the dolomite, and the whole Timeball Hill Series is now represented, including the characteristic magnetite quartzites. This locality in particular, that is, the whole of the south-western portion of Garstfontein, shows exceedingly well the folding and crumpling to which the Timeball Hill Series has been subjected, together with the numerous minor faults, which complicate the structure.

On Klapperkop the two magnetite bands crop out close together near the summit. On tracing them from here to the south-east, it will be noticed that they follow a very sinuous and generally irregular course, which is further modified by some minor faults. It happens, moreover, that the north-eastern slope of the hills often coincides very closely with the dip; so that one no longer finds a narrow band, but a dip slope of magnetite quartzite, which is repeatedly cut into by several spruits. This is best seen at some distance, as, for instance, from

Digitized by Google

the main road to Lynnwood. In order to realise the nature of the escarpments and dip slopes formed by the magnetite bands, it is highly instructive to study the view obtained from the summit of Klapperkop, looking towards the south-east.

Section No. 4, on Plate X., is taken across the boundary line between Groenkloof and Waterkloof, and shows clearly how the apparent occurrence of four magnetite bands is merely due to the complex contours of the surface.

The Nature of the Earth Movements.

In the above remarks dealing with the geological structure, the writer has so far confined himself to describing the main lines of faulting and folding, and some of their effects upon the topography. It now remains to consider the movements as a whole and to discuss their nature. To do full justice to this important aspect of the structure, it becomes necessary to take a more comprehensive view of the subject, and to remember that the neighbourhood of Pretoria forms only a small portion of the whole area throughout which these movements have taken place, and that their true significance becomes apparent only when the area of our observations is carried further afield.

It is well known that the Pretoria Series forms a belt of country extending for some distance to the east and west of the Capital, and that the conspicuous quartzites of the Magaliesberg and other ranges further south can be traced over some 60 miles to the west, forming a considerable portion of the south-western part of the Pretoria District and the southern part of the Rustenburg District.* Speaking generally, one may say that the strike to the west of Pretoria is east and west, but on the east there is a marked and sudden change of strike† towards the south-east. A line taken from Klapperkop to Franspoort, a few miles north-east of Hatherley, marks approximately the line along which the strike changes, although this transition is not equally sudden everywhere along this

* See Dr. Molengraaff's map in his "Geology of the Transvaal."

† See the maps in Annual Reports of the Geological Survey for 1903 and 1904.

Digitized by Google

Digitized by Google

Digitized by Google

line. What has been said of the Pretoria Series applies equally well to the dolomite, and both these series appear to have been bent through an angle of about 40°. It is clear that such a turning movement, in the case of a whole series of beds, cannot have taken place about a point, but if we consider the Magaliesberg Quartzite alone, then we can find in the north portion of Franspoort, that the angle of bend must lie close to a small, though well defined, highly disturbed koppie, close to and to the east of the transport road through this farm. The direction of the new strike having been defined by the quartzite of the Magaliesberg, the underlying beds of the Pretoria Series, and eventually the dolomite itself, would adjust themselves to the movements until they finally became arranged in the manner now seen in these formations. Our conception of the nature of the movements thus starts with recognising the operation of some tangential stress—acting along a north-east and south-west line—which has resulted in bending the Pretoria Series and dolomite down to the south through an angle of some 40°.

Let us now deduce the more important results of such a disturbance. The effect would be best seen over a series of formations possessing different characters, so that we should expect to find the beds of the Pretoria Series most disturbed, and more particularly the quartzites, as they are considerably harder than the thinly bedded and easily eroded shales. From what has been already stated in the previous chapter, it follows that the Timeball Hill Series, with its preponderance of shales, alternating with several thin quartzites, should show the maximum amount of movement. Then, again, it is probable, that the turning movement would form a number of planes of dislocation, dividing the area into a number of sub-parallel strips, which would be displaced relatively to one another according to some general principle—that is to say, in a south-westerly direction. More or less powerful folding would also result, which might be further complicated by passing into overfolds or thrust planes, along which blocks of strata would be pushed in a similar manner to the south-west. Hand in hand with these results would be a tendency to some elevation of the lower portion of the Pretoria Series, and, in particular, the displaced bed would tend to rise relatively to the same bed in its original position.

Turning now to the actual field evidence, how are these results borne out by nature? An examination of

Digitized by Google

the map shows the Magaliesberg quartzite practically unaffected; but the Daspoort and most of all the Timeball Hill quartzites are very much displaced, and in the latter case folded. How powerful the effects have been in the south-eastern area has already been shown above. Moreover, all the main lines of dislocation, such as the Meintjes Kop fault, follow in a general sense a south-westerly direction, and divide up our area into a number of narrow strips, which have moved by a series of steps towards the south-west, producing repeated duplication of certain beds. Hence, probably all the main faults are reversed faults dipping to the north, which have broken through the strata, and the broken end below the fault has in every case been pushed along the plane of the dislocation, so as to eventually lie underneath and dip below the bed, from which it was originally broken off. This is very well seen in the Schanskop Range between Muckleneuk and Quagga Poort. The manner in which the strata have been thrown into repeated synclines and anticlines is well shown along the outcrops of the Timeball Hill Series, and it is particularly noticeable that in the upper beds of the Pretoria Series these undulations are absent; they are, in fact, most marked along the junction between the dolomite and the Pretoria Series. Evidently the massive and generally uniform dolomite only gave way *en bloc*, whereas the rather shaly Timeball Hill Series easily gave way by means of a general crumpling and breaking up of the strata.* [See Section line No. 1, Plate XIII., and on map.]

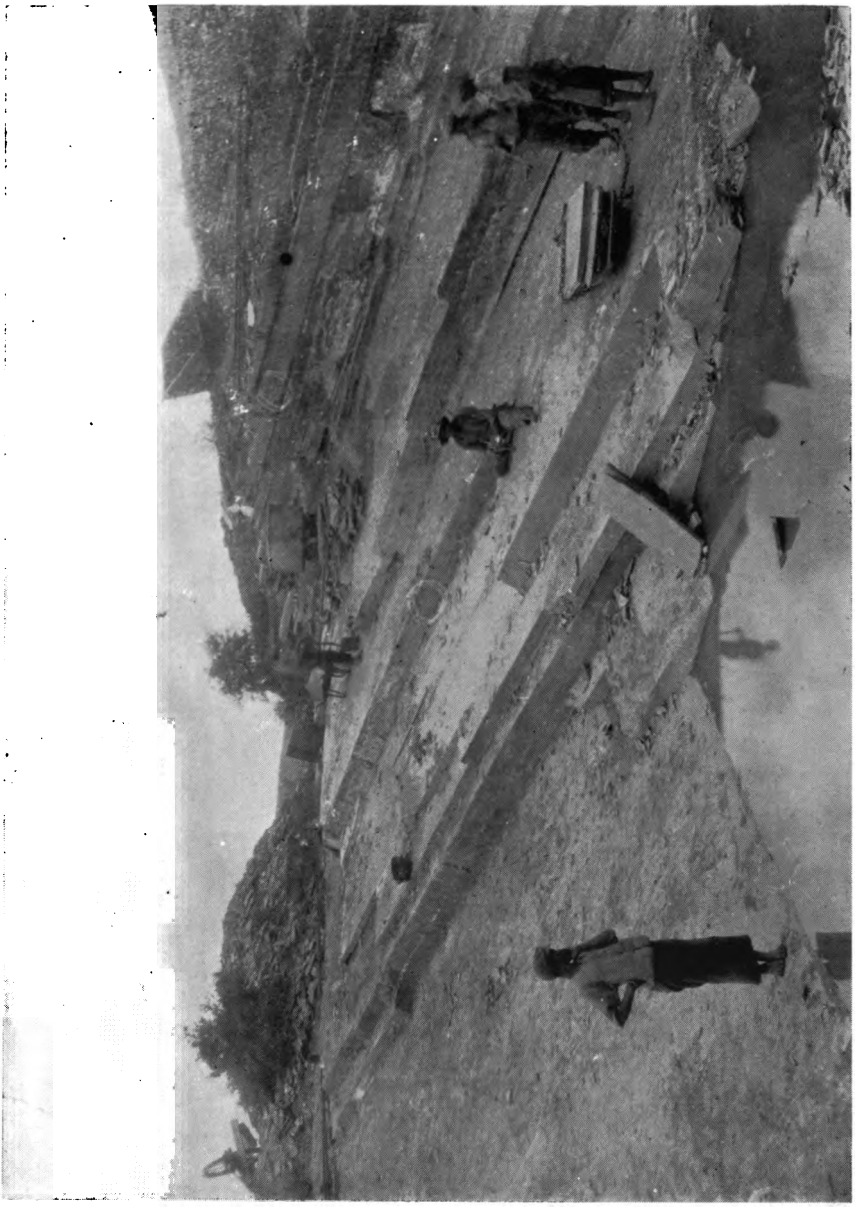
The supposition that such folds would become complicated by thrust planes is fully borne out by the structure of the Hennops River Valley, described elsewhere.† It is now well established‡ that reversed faults and thrust planes only differ in degree and not in kind, and that they constitute one of the most frequent results of tangential stresses of the earth's crust. In the Hennops River Valley, east of Irene, clear evidence occurs that the lower beds of the Pretoria Series and the dolomite have been thrown into an anticline and syncline, and that this

* Compare A. L. Hall and F. A. Steart on Folding and Faulting in the Pretoria Series and the Dolomite. Tr. S.A.G.S., Vol. VIII. See also the discussion on this paper.

† See Annual Report of the Geological Survey for 1904, "The Geology of the Hennops River Valley, south-east of Irene."

‡ See A. Heim, "Uber den Mechanismus der Gebirgsbildungen," etc., Atlas, Plate XV.

Digitized by Google



Dip Slopes of Slate (Garstfontein).

Digitized by Google

Digitized by Google

arrangement has been accompanied by a thrust plane, along which the disturbed beds have been shifted towards the south-east.

In Chapter I., in connection with the main physical features, the differences of elevation seen in the outcrops of the main quartzites were briefly alluded to, and if we consider this fact with reference to the disturbances, interesting confirmation is obtained of the general nature of the movements. Take, for instance, the case of Meintjes Kop. This hill indicates the first displacement of the Daspoort quartzite in consequence of the Meintjes Kop fault. While the general level of the undisturbed range is about 4,600 feet, the crest of Meintjes Kop is 4,712, a difference in level of 112 feet. A similar result is found on comparing the dislocations shown by the Timeball Hill Series. The summit of Proclamation Hill—the eastern termination of the undisturbed series—is at an elevation of about 4,447 feet. The highest point on the Timeball Range proper, which forms the first displacement due to the Meintjes Kop fault, is 4,905 feet ; lastly, the highest point on the Schanskop Range, which represents the second displacement due to the Struben Kop fault [see Section No. 2], is at an elevation of 5,085 feet.

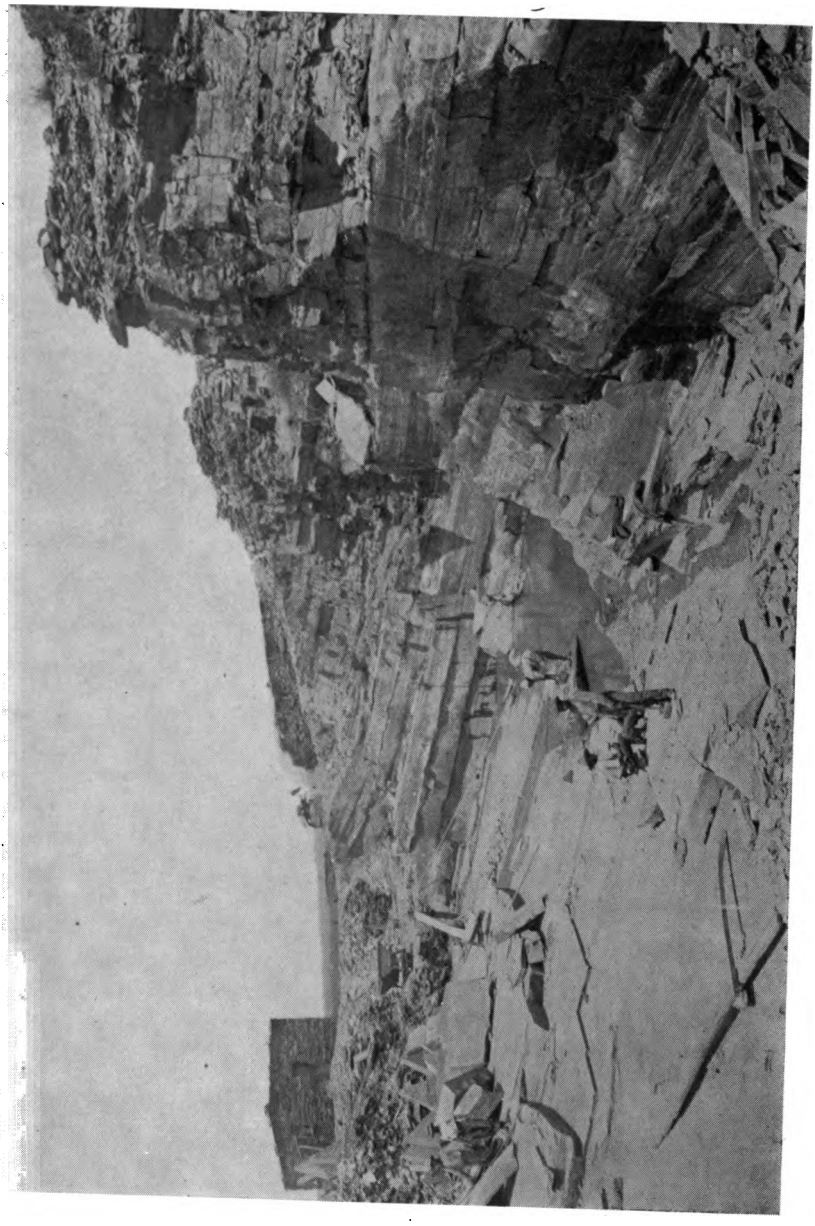
Finally, there remains one line of argument drawn from the possible occurrence of igneous rock which owe their present position to eruptive forces. All the main lines of fracture, when prolonged towards the north-east, pass to the neighbourhood of those points where diamond pipes are now situated. Thus, the line of the Meintjes Kop fault probably passes through Franspoort towards Elandsfontein, where the pipe of the Premier Mine occurs. The Struben Kop and Lynnwood faults pass through Pienaar's Poort, where there is strong evidence of fracturing, towards Zonderwater ; while another line of fault, not falling within the Pretoria map, passes from Rietvlei through Zwavelpoort, thence across the Pienaars River Valley through Donkerpoort, where it displaces the Magaliesberg Range, until it finally leads to within a few hundred yards of the Schuller and Kaalfontein diamond pipes. It has been shown elsewhere* that the diamond-

* See Ann. Rep. Geol. Surv. for 1903, page 43 ; also H. Kynaston and A. L. Hall. "The Geological Features of the Diamond Pipes of the Pretoria District." Report of the S.A.A.A.S., Johannesburg, 1903 ; also A. L. Hall, "Uber einige neue Diamantlagerstätten Transvaals." Zeitsch. f. prakt. Geol., 1904, p. 193.

Digitized by Google

iferous ground has come into its present position owing to the agency of powerful disruptive forces, and since the connection between volcanic forces and earth movements is now well known from a large number of instances all over the world, there cannot be much doubt, that the occurrence of the diamondiferous deposits must be regarded as a result of the earth movements here described, so that we derive from this argument a further confirmation of the correctness of the general principle, which as I have suggested, controls the structure of the whole area.

Digitized by Google



Slate Quarry – South Slope of Schanskop.

Digitized by Google

Digitized by Google

CHAPTER IV.

BOREHOLES.

General Remarks.

In this chapter are gathered together the records of 23 boreholes, which together will enable us to form a general conception of the underground geology across the whole area. The most northerly one is situated high up on the southern slope of the Magaliesberg ; in the extreme west there is another situated close to the Leper Asylum ; on the east we have a borehole situated on the Parkmoor Estate, a little to the north of the centre of Garstfontein No. 428 ; lastly, the most southerly borehole lies on the Old Natal Road, within the limits of the Government farm Groenkloof, and about a quarter of a mile north-west of the farm boundary of Erasmusdam No. 420. Obviously, the majority of the holes are situated close to or within the municipal boundaries. With two or three exceptions the necessary collection and examination of the records involved considerable difficulties. In the first place, the usual object for which this kind of work is undertaken is generally to obtain water, and the nature of the formations passed through is only considered in so far as this affects the working costs or is likely to offer special difficulties to the engineer. In the second place, no systematic effort has been made in the past, as far as I am aware, to place on record the result of any particular borehole, and, moreover, some of them date a considerable time back, as, for instance, one of the boreholes in the Trevenna Brewery in Esselen Street. In such cases not only are the data lost, but no information can be obtained to show by whom the undertaking was carried out. Lastly, whenever these boreholes are made by jumper drills, and thus yield no solid cores, it is particularly difficult to obtain accurate records owing to the condition of the material brought up.

For this reason no absolute accuracy is claimed for the results given below. Such records are of particular importance and interest in helping to control, improve, or even correct the evidence obtained from an examination

Digitized by Google

of the surface, especially where, as within the limits of the Municipality, the natural surface is largely obscured by cultivation, streets, houses, etc. Secondly, such borehole records are of particular value in showing at what various depths water was first met with.

On the map the position of each borehole is marked and accompanied by a number in agreement with the order given below. The boreholes situated near the town are dealt with first.

DESCRIPTION OF BOREHOLES IN OR CLOSE TO THE TOWN.

Borehole No. 1, *Bryntirion.*—This borehole is situated on the Bryntirion Estate on the north side of the Meintjes Kop range, and a little to the south of the main road, which leads from the Reviera Township towards Derdepoort. The first 84 feet showed yellow and red clayey soil, in which a certain amount of water was found from a depth of 60 feet downwards. Then followed 24 feet of quartzitic sandstone, which between the depth of 104 and 190 feet is underlain by a rather coarse diabase, followed by the beds of quartzite which crop out along the hill range south of the hole. The maximum depth reached by February, 1905, was 272 feet, when the cores showed hard blue-grayish quartzite. The first water, which was met with at a depth of about 60 feet, continued for another 50 to 60 feet, and then ceased. Below this no further water-bearing strata have been found. The dip of the main quartzite varies from 28° to 32°, and this value brings the upper boundary of the formation with very close approximation into the position where it is first encountered by the borehole at a depth of about 190 feet. The underground evidence proves the presence of a diabase intrusion, which is, however, not shown on the map for the reason, that it cannot be seen owing to the great thickness of surface wash. There is little doubt that this sheet is identical with the one cropping out at Silverton along a strictly analogous horizon with reference to the Daspoort quartzite.

Borehole No. 2, *Rissik Estate.*—This hole is situated near No. 7 Hospital, and, like the preceding, is the work of a diamond drill. The core was started at a depth of 60 feet, which represents the bottom of older workings, and continued to 210 feet. The first 60 feet from the surface downwards consists of yellow soil, which gradually becomes harder and passes into a hard, fine-grained, bluish

Digitized by Google

rock, which continues as far as the hole was sunk—210 feet. A sample core taken from a depth of 190 feet shows a compact, pale blue, slaty rock, with thin, rather black, cherty bands. No diabase was met with, which agrees with the general distribution of the formations over this area.

Boreholes Nos. 3, 4, 5, *Gezina.*—These three boreholes are situated in close proximity to one another, and may be conveniently treated together. No. 3 lies on Erf No. 566, close to and on the east side of the main north road. No. 4 was put down on Erf No. 465, about 300 yards north of No. 3, while No. 5 occurs about 200 yards due east of No. 4 (see map). The maximum depth reached varies from 70 to 190 feet. The first 60 feet is represented by a gravelly clay, which is followed by a hard, gray quartzitic rock. The first water in borehole No. 3 was struck at 69 feet.

Borehole No. 6, *Esselen Street, Sunnyside.*—This hole was sunk opposite the Trevenna Brewery, and traversed only diabase throughout its total depth of 113 feet. The rock brought up was of a vesicalar character, with partings showing asbestos. Reference to the map shows, that we are obviously dealing with the big sheet of amygdaloidal diabase referred to above in Chapter II., which traverses the northern portion of Sunnyside. The first water was found at a depth of 53 feet, and when the drill was at 84 feet a plentiful supply was forthcoming.

Borehole No. 7, *Trevenna Brewery, Sunnyside.*—At this locality there appear to be three boreholes. One of these was made before the war, and records cannot be obtained. Another hole was put down later, but of this also no records appear to be in existence. The third hole is of more recent date, and traverses only diabase throughout a depth of over 50 feet. Water begins to come in at 32 feet, and a good supply was obtained. The sheet of igneous rock is the same vesicular diabase struck in the preceding borehole.

Borehole No. 8.—Corner of Klein Skeiding and De Greef Street, Sunnyside, situated on the south-east corner of Krohn's Nursery. The maximum depth reached was 93½ feet, the whole section being in diabase. After reaching the first water at 57 feet, a good supply was obtained. The records of this hole are analogous to the results obtained from Nos. 6 and 7.

Digitized by Google

Borehole No. 9.—This has been sunk at the corner of Klein Skeiding Street and Jubilee Square in Sunnyside. It traverses shale only, and evidently just misses the lower boundary of the big intrusion of vesicular diabase. The first six feet consist of soil, then from 6 to 24 feet follows, decomposed shale passing into a harder (at 36 feet), greenish shale, extending as far as the hole goes, that is, down to 80 feet.

Borehole No. 10.—Situated in Troye Street, above Rissik Street, Sunnyside, and entirely in shale down to the maximum depth of 89 feet. This agrees with the geology as seen on the surface.

Borehole No. 11.—Church Hill, east of the town. The hole is sunk near the south-western corner of the property of Mr. T. W. Beckett, and is remarkable owing to the fact that no water was found. Down to 16 feet the hole shows soft diabase, then from 16 to 160 follows hard diabase, which is underlain by "gray quartzite" to the maximum depth reached of 250 feet. It is difficult to understand where the "quartzite" comes in, as it cannot belong to the series cropping out along the range to the north. Possibly the rock referred to as "grey quartzite" requires closer examination.

Borehole No. 12, *Prison Reserve.*—This borehole lies on the west side of and close to the main road which runs due south from the railway bridge over Potgieter Street. From the surface to a depth of 41 feet soft, clayey material is traversed; this is followed by 19 feet of soft rock and sand, then follow 42 feet of diabase commencing with 13 feet of decomposed rock carrying less weathered diabase boulders. The maximum depth reached was 103 feet, but already at a depth of 20 feet water began to appear.

Borehole No. 13, *Magazine Redoubt.*—About a quarter of a mile to the south-west of No. 12 lies another hole on the northern slope of the hill marked by the Magazine Redoubt. Here the beds are dipping north at an average angle of 36°. The maximum depth reached is nearly 140 feet. The first 47 feet pierce red and yellow soft clay shale, then follows 3 feet of hard magnetic quartzite. These are underlain by a continuous sequence of red and yellow soft shales, with occasional bands of hard blue rock of the same formation. There are no diabases which agrees with the surface indications. The band of magnetic quartzite struck at a depth of 47 feet represents the upper bed; the lower one, judging from the position of the borehole,

Digitized by Google

would not be struck until a much greater depth was reached. The first water was found at the level of 91½ feet.

Borehole No. 14, *Proes Street.*—This hole is situated on the site of the old Trevenna Brewery at the corner of Koch and Proes Streets, opposite the Gymnasium Buildings. The hole bored by the diamond drill starts at a depth of 80 feet, and continues down to 99, traversing diabase all the way, and it is probable that the same rock continues up to the surface. At the depth of 99 feet a plentiful supply of water is obtained.

Borehole No. 15, *Vermeulen Street*, situated in the yard of the De Hoop Mineral Water Factory. This hole was made with a jumper drill, and no reliable records are obtainable. A few yards to the south of the hole is an open well, showing good outcrops of well bedded shales. From such material as is available it is probable, that near the bottom of the hole, the maximum depth of which is 255 feet, diabase comes in, while at lesser depths shales are present.

Borehole No. 16, *Sunnyside*, situated in Klein Skeiding Street, a little to the south-west of No. 6. The hole traverses diabase down to 50 feet, and evidently pierces the large vesicular intrusion seen in connection with boreholes No. 6, 7, and 8.

BOREHOLES IN THE NEIGHBOURHOOD OF PRETORIA.

Borehole No. 17, *Parkmoor Estate.*—On Garstfontein No. 428, a short distance south-east of Wilson's Farm; down to a depth of 126 feet, only one type of rock—shales—have been traversed. To a depth of 20 feet soft, decomposed rock occurs, which between 20 and 50 feet becomes harder, while from 50 feet downwards the core consists of a hard, fine-grained, bluish rock, resembling the lowermost material from No. 2 borehole.

Borehole No. 18, *Brooklyn.*—This locality lies about a mile north-west of McKenzie's Farm, and has a deep well going down some 90 feet. It shows throughout the characteristic vesicular diabase, and is sunk well into this thick sheet. The material is identical with that brought up from the holes in Esselen Street, Sunnyside.

Borehole No. 19, *Lunatic Asylum.*—The hole is situated south-west of the Lunatic Asylum, and passes first through 6 feet of sand, then follows 26 feet of soft clay-shale; from 32 to 63 feet follows bluish shale; lastly comes

Digitized by Google

decomposed diabase, with boulders of the same rock down to a depth of 70 feet, when plenty of water was met with. The record agrees with the sequence of formation as deduced from the surface examination.

Borehole No. 20, *Leper Asylum.*—The position of this borehole is a little to the north of the Leper Asylum, and close to the southern slope of the Daspoort Range. The maximum depth reached is 400 feet. Of this the first 70 feet consist of clayey shale; from 70–400 feet consist of diabase.

Borehole No. 21, *Groen Kloof.*—Situated on the Old Natal or Standerton Road, in the south-east corner of the Government farm Groen Kloof. From the surface down to a depth of 98 feet occurs what is described as decomposed yellow rock; between 98 and 113 feet this becomes harder; from 113 to 165 feet follows a similar rock, but more fine-grained, and not until a depth of about 180 feet does the first undoubted dolomite come in. Water begins to appear at 113 feet. This hole is situated well within the upper limit of the dolomite, so that it is peculiar that the genuine dolomite itself should only have been reached after boring down to a depth of 180 feet. It is possible that owing to its position in a valley a considerable thickness of drift had accumulated, which had first to be pierced before reaching the formation *in situ*. (Compare result of borehole No. 22.)

Borehole No. 22, *near Cantonments.*—The position of this hole is on dolomite close to the main road to Potchefstroom, on comparatively high ground. No water was obtained from this locality, and after going down to a depth of 200 feet the work was abandoned. After traversing 24 feet of red surface soil, the strata passed through consisted of red shales with quartz veins down to 48 feet; then followed clay and shales until at 67 feet the dolomite first appeared in the form of boulders. From 71–199 feet red clay and sandy shale came in. Probably the dolomite has disappeared down to a considerable depth, and only the more siliceous portion remains.

Borehole No. 23, *Magaliesberg.*—Situated north of Gezina, high up on the southern slope of the Magaliesberg. The work was done by a jumper drill. The first 35 feet passed through reddish subsoil. From 35 feet down to 150 feet diabase was met with. The first water occurred at a depth of 70 feet, but was not sufficient for the purpose, for which it was required.

Digitized by Google

CHAPTER V.

ECONOMIC GEOLOGY.

Under this head we shall deal with those economically exploited natural products, which depend, more or less, directly upon the goelogical nature of the area from which they are drawn. In this connection, the production of building stone, slate, bricks, and cement will be discussed, and what is undoubtedly most important of all, the geological conditions affecting the Pretoria water supply.

WATER SUPPLY.

It has been stated and not without reason, that the water supply of the Capital is unsurpassed by that of any other town in South Africa, and it undoubtedly constitutes one of the most valuable assets of the Municipality. The water comes to the surface in two springs, situated at the locality known as the Fountains, on the east side of the Johannesburg railway, between the stations of Ashbury and the Fountains. The formation, through which these springs rise, is the dolomite, but in both cases the shales of the Pretoria Series are only a few yards distant, and it is very likely that the immediate cause of the springs being brought to the surface, must be sought for in the occurrence of a fault, which breaks through the Schanskop range, along an approximate north and south line, displaces the Timeball Hill Series towards the south of the main range and then follows the valley of the Aapies River as far as Ashbury Station. There is a considerable amount of alluvial soil present round the fountains and, in consequence, it is by no means easy to accurately define the fault line, but where the road leading to the Upper Spring crosses the Aapies River, good outcrops occur, which show some effects of faulting.

The two springs are known as the Upper and Lower Springs, separated from one another by a few hundred yards. The Upper Spring has an elevation of 4,525 feet, or 75 feet above Pretoria Station, and its water supplies

Digitized by Google

the town proper, which it reaches by gravity alone. At about the centre of the fenced Municipal ground surrounding the Upper Spring, there is a small area enclosed by a high wall of corrugated iron, within which lies the well, enclosing the spring. This well is about 14 feet deep, and forms the three sides of an oblong. At the bottom rises the main Upper Spring, filling the floor of the well to a depth varying according to the time of day and other circumstances, from a few inches to a few feet. The intake of the water consists of a sixteen inch pipe, which is usually more than half filled with the inrushing water ; a few hundred feet further north, this gives place to a twelve inch pipe, through which the water finds its way to the town. At the other end of the oblong are a number of small minor springs, the outflow of which runs towards the main spring, while about two or three feet above the bottom of the well, a large opening in the wall allows the excess of accumulated spring water to drain into the Aapies River, which lies a few yards to the east of the enclosure.

The lower spring has an elevation of 4,510 feet, or 15 feet below the level of the upper intake. Its water supplies the suburbs and is also pumped to the Cantonments to supply the military.

The yield from both sources is about four and a half million gallons per day, but it has been stated that the supply in former years was greater. (See annexed table.)

It is clear that the supply of water must ultimately depend upon the rainfall, but only a small proportion of the rain water actually enters the dolomite, and this swells the available spring water, the greater part being lost by running off the surface and by evaporation. To ascertain this percentage of infiltration naturally requires many experiments, made not only for each formation, but for separate hydrographic areas .If one marks off as nearly as possible the visible geographical catchment area, that is, the ground over which the rain-water would naturally drain towards the Fountains, it is found to measure from 15 to 20 square miles. Taking the higher figure and combining this with an annual rainfall of 26 inches—if anything, a high estimate—then a daily yield of four and a half million gallons would require 21.4 per cent of the rain water to filter into the ground. This is certainly a high estimate and probably half this figure would be

Digitized by Google

nearer the truth, so that, the visible catchment area being limited, we must suppose, that the springs at the Fountains are partly fed from an underground area, extending beyond the southern edge of the geographical drainage basin, though how far, it is difficult to say.

The composition of the Pretoria water indicates that it has arisen from a dolomite formation, as is shown from the following data.

Analysis of Pretoria Water in parts per million :—

Sio2	..	..	13.8
Mgo	..	..	38.4
Cao	..	..	52.2
			104.4 Parts per million.

Digitized by Google

TABLE SHOWING THE DIMINUTION IN THE PRETORIA WATER SUPPLY.

	GALLONS PER DAY.							
	Mr. Bocks gauging Oct., 1892.	A. Karlson gauging approx. Sept., Dec., 1898.	A. Karlson gauging exact May, 1899.	A. Karlson gauging exact May, 1901.	A. Karlson gauging exact March, 1903	TOTAL DECREASE.		
						In gallons.	Per cent. Original flow.	Per cent. Present flow.
Upper Spring	3,320,000	3,300,000	2,868,000	2,276,000*	2,388,000	932,000	28	39
Lower Spring	4,233,000	3,570,000	3,371,000	3,128,000	2,789,000	1,444,000	34	52
Total	7,553,000	6,870,000	6,239,000	5,404,000	5,177,000	2,376,000	31·5	46

* No night observation taken.

DECREASE.	683,000 gallons in 6 years, or 114,000 gallons per annum.	631,000 gallons in six months, or 1,262,000 gallons per annum.	835,000 gallons in two years, or 417,000 gallons per annum.	227,000 gallons in two years, or 114,000 gallons per annum.

Digitized by Google

In the description of the geological structure in Chapter III., allusion was made to the effects which the general bending of the formation towards the south-west has had in the mode of arrangements of the lower beds of the Pretoria Series and on the dolomite. An examination of the extent of the underground supply and its probable mode of issue must take into account, not only the powerful and extensive faults, such as the Struben Kop, close to the Capital, but should also include the area to the south-east of Irene, which shows an over-thrusted anticline of dolomite. Thus, it is very likely, that the ease with which water is obtained all over Brooklyn is connected with the effects of the Struben Kop fault on the underground circulation. Then again, the dolomite anticline over the eastern portion of Rietvlei, which extends along the old Natal Road, towards Bronkhorstfontein, and is underlain by impervious shales, very probably affects the town supply, owing to the occurrence of the big fault which extends from Donkerpoort through Zwavelpoort and across the northern portion of Rietvlei. This aspect of the question is discussed in the Annual Report of the Geological Survey for 1904.*

Cement.

The cement works are situated close to the left bank of the Aapies River, about half a mile north of Daspoort. The raw materials used for the manufacture consists of limestone and clay. Hitherto all the calcareous material came from the farm Rhenosterspruit, No. 579, south-west of Pretoria, out of the dolomite. This material, however, is not true dolomite, but consists largely of arragonite, deposited in thin layers analogous to those found in caves. In colour it varies from dirty white to brownish, and shows occasional fragments of quartzite, shale and diabase, with a few leaf impressions. No doubt it is of secondary origin. The material is rich in lime, averaging about 94 per cent. of carbonate of calcium. This rock has to be brought by traction engine from a distance of about 24 miles and is, therefore, somewhat expensive. A substitute, however, has been found further north, from the neighbourhood of Pienaars River Station, carrying 82 per cent of carbonate of calcium, and this is being used to replace

* A. L. Hall, "The Geology of the Hennops River valley south-east of Irene," Annual Report for 1904, p.——

Digitized by Google

the old material. Another calcareous deposit from near Pietpotgietersrust shows 94 per cent of calcium carbonate. By using these raw materials it is expected that the cost of transport will be materially lessened. Clay forms the second raw constituent and lies close at hand in the hard Pretoria shales between the factory and Daspoort.

After crushing and grinding the shales, they are burnt, to form what is known as " clinker," which is broken and pulverised, ready for use. The limestone blocks are likewise crushed, and burnt. The mixed lime and clay are introduced into a tubular furnace, six and a half feet in diameter and seventy feet long ; the material issuing from this is practically ready for the market. The more modern method involved in this treatment is more expeditious, and far more economical than the old method of shaping the prepared raw material into bricks and burning these subsequently. Thus the tubular furnace can be attended to by one man and two boys, whereas the same branch of the manufacture required 70 boys under the old system.

The output of this important industry is about 5,000 bags per month, each bag averaging 185 lbs., in weight.

Bricks.

At a number of localities principally south of Pretoria, occur suitable deposits for brickmaking. The raw material used for this purpose lies nearly along the same geological horizon, that is, between the Timeball Hill Series and the dolomite, more or less at the foot of the gentle hollow which runs along the junction of these formations. In the extreme west, we have the brickfields south of Quagga Poort, then follow those east of the Cantonments at the foot of the northern side of Schanskop, while others are to be found west and north-east of the Fountains, at Muckleneuk and elsewhere. All along this line the lowermost shales of the Pretoria Series and the uppermost beds of the dolomite are highly decomposed and softened, thus giving rise to a considerable deposit of clayey soil, suitable for the production of bricks, pipes, etc. The bulk of the industry is carried on in the primitive style, by manual labour, but occassionally proper manufacturing plants have been set up, as at the Fountain Grove Brickyards, at the foot of the northern slope of Klapper Kop.

Digitized by Google

Slates and Building Stones.

Slates.—The most favourable area to obtain slates, suitable for economic purposes, is below the basal quartzite of the Timeball Hill Series. The slate quarries lie generally near and at a slightly higher level than the brickfields. Abundant material is present, but the demand for the same does not seem to be very great. These slates consist of hard compact, dark bluish beds of the lowermost Pretoria Series. In the quarry situated on the southern slope of Schanskop, the very regular dip of the slates is well seen. Slabs of considerable size and almost perfect uniformity are here obtained, some of them reaching a size of 12 x 12 feet. Owing to the fact that these beds are fissile to a limited degree only, they are not suited for roofing slates, but form excellent flags or paving stones. In the Schanskop quarry the hard slates have been proved over a thickness of 40 feet, but there is little doubt that they extend to a greater depth.

Stone.—The hard quartzite and some of the more compact shales and grey quartzite are extensively quarried for building-stone and road metal. The principal sources are along the base of the Daspoort Quartzite, as near Meintjes Kop, near the northern end of Market Street, at Daspoort, and elsewhere. A considerable quantity of road metal is obtained from the harder beds of the Timeball Hill Series, south of the Station.

Some idea of the output of these economic products is obtained from the following figures :—

Output for the half year ending December 31, 1904.

Stone	8,152	cubic yards.
Slate	45	cubic yards.
Cement	1,023	tons.
No. of machine made bricks	5½	million (apprx.)

Digitized by Google

Digitized by Google

Digitized by Google

14 DAY USE
RETURN TO DESK FROM WHICH BORROWED
EARTH SCIENCES LIBRARY

This book is due on the last date stamped below, or
on the date to which renewed.
Renewed books are subject to immediate recall.

LD 21—40m-5,'65
(F4308s10)476

General Library
University of California
Berkeley

Digitized by Google